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SOME CURIOUS FACTS IN PLANT DISTRIBUTION.

By W. Botting Hemsley, F.R.S.

THE present distribution of plants apart from those low in the scale of organisms, exhibits some very curious phenomena. Perhaps those most obvious to the majority of persons are consequent upon the spread of European peoples over other parts of the globe. The domestic weeds of ancient civilization, the road-side weeds and the cornfield weeds, have accompanied man in his most distant wanderings, and in many instances have developed increased vigour and a power of colonization unsurpassed by man himself. In some instances the reproduction and spread of these weeds is so rapid as to become a great scourge to agriculture, overrunning and destroying crops almost as effectually as swarms of locusts; and laws have been framed making it compulsory on farmers to keep their land free of these prolific strangers. Sometimes it is a new weed that makes its appearance and propagates itself in this extraordinary manner, advancing from field to field, farm to farm, county to county, and State to State, at an incredible pace. During the last three or four years the so-called Russian thistle (*Salsola Kali*, var. *Tragus*) has been occupying the serious attention of the farmers and legislators of the Eastern and Central States of North America, and it is already the subject of a considerable literature. Thousands of square miles are infested, and the loss resulting therefrom in 1892 was estimated to exceed two million dollars!

But the object of this article is to direct attention to some of the phenomena of the distribution and existence of plants in nature, uninfluenced and unaffected by man, either directly or indirectly—that is to say, to the latitudinal limits, the altitudinal limits, and other interesting facts of the present distribution of flowering plants.

In the highest latitudes yet reached in the west, in Ellesmere Land and Grinnell Land, between 80° and 83° 6′ north latitude, the ground in localities the most favourable to the development of vegetation is carpeted with plants, many of them having brilliantly coloured flowers, produced in great profusion during the short but continuous summer that there obtains. About seventy species were collected within the latitudes named by the naturalists of the last British Polar Expedition, and they included such familiar showy plants as *Papaver alpinum*, *Silene acaulis*, *Dryas octopetala*, *Saxifraga oppositifolia*, and *Epilobium latifolium*.

The Austrians found a very different condition of things in the same latitudes in Franz Josef Land, eastward of Spitzbergen. Plants were found, and of the same species, but in an extremely stunted state, with scarcely a flower to be seen, and nowhere was there continuous vegetation a few square feet in extent.

In these very high latitudes seed is rarely, if ever, perfected, and plants increase only by vegetative development—suckers, underground stems, and trailing rooting stems. Yet the greatest cold experienced—upwards of one hundred degrees (Fahrenheit) of frost—did not impair the vitality of wheat that had been fully exposed for four winters and four summers. It should be mentioned that none of the plants inhabiting these high latitudes are peculiar to the region; that very few species are confined to the Arctic regions; and that many of them are widely spread in Alpine regions of lower latitudes, some even recurring on the mountains within the tropics, and a few reach the southern limits of vegetation.

In the southern hemisphere there are now no flowering (*phanerogamic*) plants growing within thirty-five degrees of the Pole,* and countries in as high a latitude as Scotland are absolutely ice-bound. South Georgia, in the American region, and Macquarie Island, in the New Zealand region, may serve to illustrate the Antarctic flora and the southern limits of flowering plants. They are small islands of comparatively slight elevation, and both situated in 54° south latitude. South Georgia is about a thousand miles east of Cape Horn, and nearly as far from the Falkland Islands, the nearest land, except some very small islands concerning the vegetation of which nothing is known.

Its exceedingly meagre flora has probably been exhaustively investigated, and the result is a list of thirteen species of flowering plants and no ferns. Not one of these species is peculiar to the island, and nine out of the thirteen inhabit both the American and the Australasian or New Zealand regions. When we remember that the Antarctic flora now exists only in such isolated and distant fragments, we are hardly prepared to find almost the same homogeneity as in the north, where there is practically a continuity of land. Yet so it is; and the only satisfactory solution of the problem is a former greater land connection and continuous flora, probably in higher latitudes than the existing fragments. One of the tasks of Antarctic explorers is to search for fossil remains, which might

* Should there be no error in locality, there is a single known exception. In the Kew Herbarium is a specimen of a grass (*Aira antarctica*) labelled: "New South Shetland, Dr. Eights."

give a clue to the history of plant life under different conditions.

A noteworthy feature in the small flora of South Georgia is the presence of three northern plants, namely, *Montia fontana*, *Callitriche verna*, and *Phleum alpinum*. Two out of three of these plants are also found in the New Zealand region. As previously mentioned, some northern species extend into the southern hemisphere, but no essentially Antarctic types extend into the northern. The farthest they reach are the Alps of Victoria and the Andes of South America, where a very few outliers occur.

Another peculiarity of the highest Antarctic flora is the almost total absence of colour in the flowers, which are, moreover, exceedingly small. Butterflies and bees are also absent, whereas they abound in the north, where showy flowers are found.

The flora of Macquarie Island, on the opposite side of the world from South Georgia, although very poor, and possessing no endemic element worth mentioning, presents more striking features. For example, there is one very showy plant allied to the Michaelmas daisies, and another, *Stilbocarpa polaris*, belonging to the same family as the ivy, having very large and handsome leaves. Yet, although the climate is much less rigorous than in South Georgia, there is no shrubby plant of larger dimensions than common thyme; and the whole flora consists of less than thirty species. Comparisons with other islands I must leave for a future article.

WAVES.—II.

THE WAVES OF THE SEA SHORE.

By Vaughan Cornish, M.Sc.

WHEN the ocean wave reaches the shallowing slopes of the sea shore, the water particles no longer swing freely in the circular orbit which gives rise to the simple form of the deep-sea swell. The circular swing of each particle is exchanged for an elliptical motion, the vertical diameter of the circle being shortened when the depth of the water is no longer great compared with the wave-length, or distance from crest to crest. With the change in the motion of each water particle, which cannot itself be followed by the eye, comes the change in the visible form of the undulating surface of the sea. When the wave is running freely in deep water each crest is preceded and followed by a trough of the same shape and size. Fig. 1 represents the modification of the wave-form in shallowing water. The front of the wave becomes steeper, the back more sloping, until the crest of the wave has the cusped form; when we have reached the breaker, and the crest topples over in a mass of foaming water. This progressive change of form can be better observed from a pier than from the beach, where the troughs and backs of the waves cannot be clearly seen. The cause of these progressive changes in the wave-form is the slower transmission of wave-motion through shallow water. When the distance of the sea-bottom is no longer great compared with the dimensions of the wave, the forward movement of the wave is retarded, and, moreover, the drag on the wave's motion is greater in the trough of the wave than at its crest, where the depth of the water is greater. Hence the crest gets more and more ahead of the following trough, until at last we reach the critical moment when it catches up the preceding trough, overhangs the hollow with a trembling cusp, and then breaks. According to Scott Russell's observations, this occurs when the height of the crest above the general level of the water is equal to the depth of the water at that place.

Everyone who has watched the breakers of a stormy sea has noticed the occasional arrival of succeeding breakers of exceptional size, and the occasional occurrence of nearly smooth water. This is due to the coincidence of two or more sets of waves, the result being a complex wave in which the motion of each particle of water at any position is the result of two or more impulses. The amount of the resulting displacement at any point is either the sum or the difference of the several displacements, according as they are at the moment in the same or in opposite directions. The lowest curve in Fig. 2 represents a wave-form in which rough and comparatively smooth water alternate with one another. This curve is drawn by compounding the two upper curves, each of which represents a simple wave. The length from crest to crest is slightly different in the two cases. In sections A and C the simultaneous displacements are in the same direction in the two waves; crest nearly coincides with crest, and we have rough water. In section B the simultaneous displacements are in opposite directions; what would be the crest of the first wave (if the wave were travelling by itself) nearly coincides with the position which in the second wave would be a trough. The resulting disturbance in the actual complex wave is therefore very slight, and there is comparatively smooth water in section B. The wave is supposed to be travelling to the right, so that section C will give large breakers when it reaches the shore, which will be followed by small breakers when section B reaches the shore. It is by availing themselves of the succession of rough water by smooth that skilful boatmen safely beach their small craft in a rough sea. Early training and long practice appear to give them a remarkable power of analysing the components of a complex wave. In rough weather off a shallow shore there are generally several waves breaking at the same instant at different distances from the beach. This would be difficult to understand if the wave-form were a simple one; but with the more usual complex waves, it is easy to see that there may be a smaller wave breaking near the shore and a larger wave breaking simultaneously in deeper water. On a steep shore the wave phenomena terminate with the breaker; on a flat shore it is not so. From each succeeding breaker the

Fig. 1.—The Forming of the Breaker.

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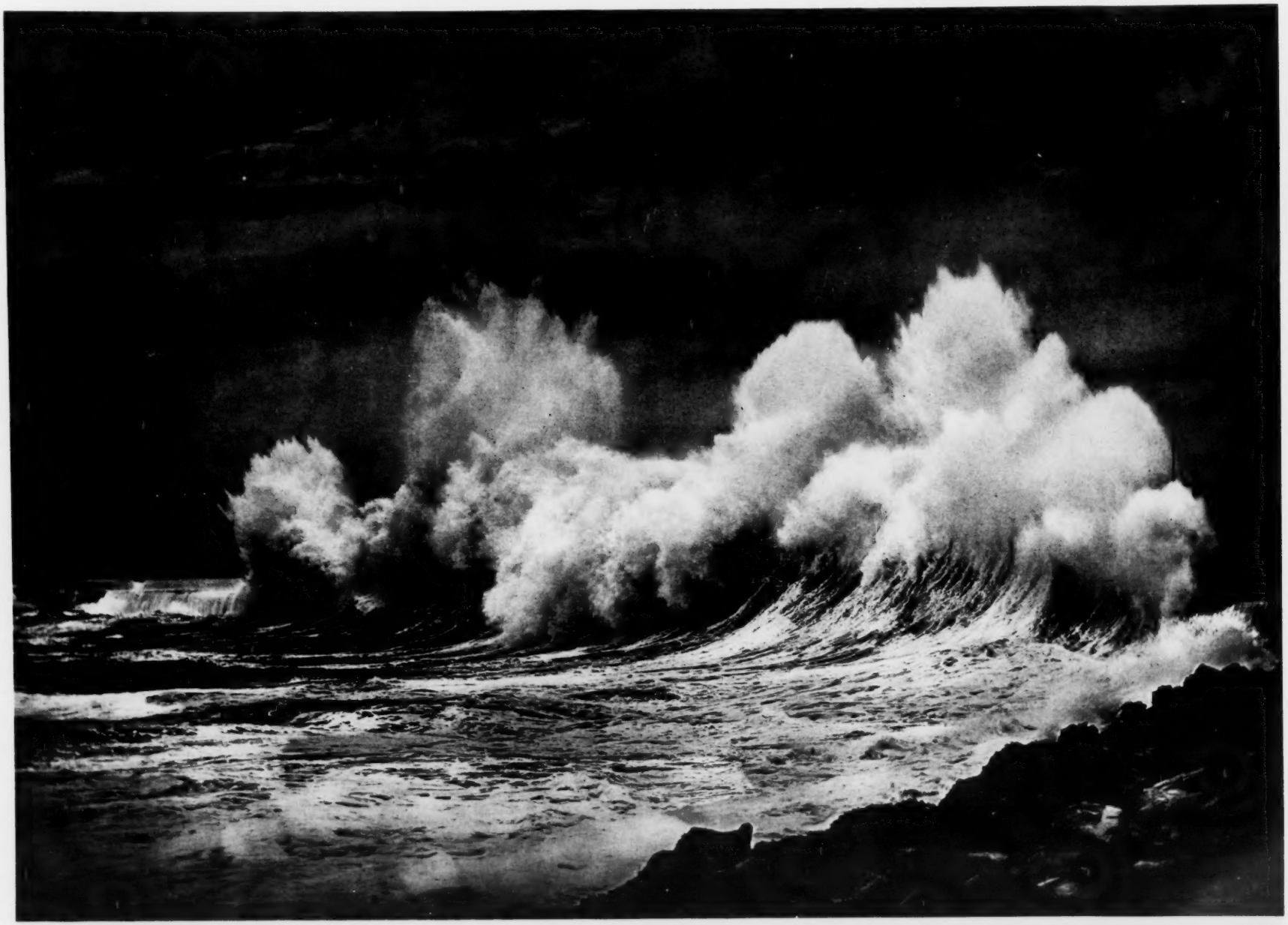

THE BREAKWATER AT COLOMBO DURING THE S.W. MONSOON.

Reproduced by permission from the photograph by Capt. F. Bayley.

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water rolls forward on a flat shore in a new form of wave, called the solitary wave, or wave of translation. Fig. 3 illustrates this condition of things. The characters of the solitary wave will be discussed in a later article.

One of the first problems which presents itself to the watcher of waves is the circumstance that, at the opposite shore of a bay, across which we will suppose him to look, the waves travel in exactly the opposite sense (or direction) to those which roll in to the beach on which he stands. To all appearance the waves, when the air is calm, come from some distant source of disturbance—say in the open ocean—and there seems at first no obvious reason why the waves should advance directly upon every part of the shore however much the shore line may twist and turn, so that at every part of the shore the line of breakers, and the crests immediately following the breakers, are parallel to the beach. This is due to the circumstance already mentioned that the progress of a wave becomes slower as the depth of the water becomes less and less. Thus, if a wave crest enter a bay or inlet, the middle part, which is in deep water, will retain its velocity, whilst to right and left the wave is retarded. Where the drag of the sea-bottom is felt the wave hangs back, and the crest swings round each cape or promontory, as a line of soldiers wheels on parade, when the inside man marks time and the outside man marches at the regulation rate. Thus the wave crest wheels and advances towards the beach, its whole length being nearly parallel to the shore at the time the crest begins to break. Those parts of the crest which are a little further from the beach are travelling faster, and quickly come alongside the breaking portion of the crest. At the edge of the shore every circumstance combines to give the impression that the waves for a considerable distance out to sea are advancing directly upon the beach. From the top of a moderate cliff it is, however, easy to see that this is to some extent an illusion. In a side wind, especially, it is only close in shore that the wave crests range themselves in long ridges approximately parallel to the beach.

When the wind sets in at an angle with the shore line, and the waves are no longer free but forced, the windward end of the breaker breaks first, and the curling cusp runs to leeward along the crest as the wave swings round, each portion of the crest successively discharging itself upon the beach when it reaches about the same distance from the shore line as that at which the windward end of the wave first broke. The line to which the surf reaches is consequently very nearly parallel to the shore line. When a light side wind springs up across a sea still agitated from former winds, or from a distant storm, two sets of breakers may sometimes be perceived, the larger rolling in directly upon the shore, and the smaller (small both in height and in length and moving slowly) coming in at an angle, and breaking first at the windward end. More often than not the smaller, slanting wave is caught up and smothered by the larger and quicker waves, so that it is only occasionally, at opportune moments, that the little side waves are able to discharge themselves upon the beach. There is another point to be noticed when a side wind sends smaller undulations athwart the larger waves. These smaller undulations may be observed to indent, or serrate, the crests of the larger waves, carving them into ridge and furrow. If the eye be turned to the roller immediately behind the breaker it will often be noticed that the crest is not a straight line, but has an undulating form. Now let the eye follow this roller as it nears the shore, and becomes in its turn the breaking wave. The crest is higher in some places than in others; the water there is deeper, and these parts of the crest, therefore, move faster than the lower parts. They consequently break first; and by rapidly running the eye along the crest of the breaking wave one may see that there are a number of portions of the wave of about equal length where the crest is breaking, and that these breaking portions are separated by unbroken portions which are the troughs of the sideways undulation.

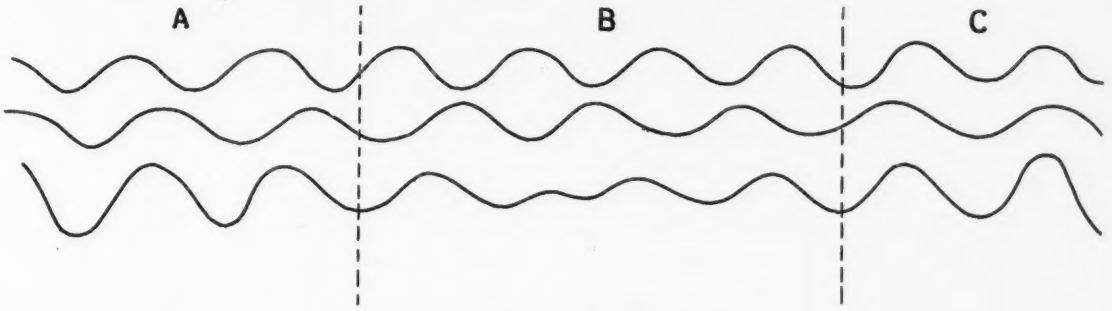


FIG. 2.—The Alternation of Rough and Smooth Water.

When large waves are rolling in to shore on a calm day after a storm, one may sometimes see breakers with straight, unfurrowed crest, which come in direct and discharge themselves simultaneously along their whole length with thundering sound. On a flat shore the finest breakers are these given by the ground swell, especially in a light off-shore wind, when the great wave slides smoothly on to the very margin of the water and discharges itself right upon the beach.

The simple heave of the ground swell is, however, an exceptional condition of the sea. Generally the surface is covered with undulations of various size, moving independently in different directions, which the watcher of waves cannot too early accustom himself to detect. One of the most familiar beauties of the sea, the laughter of the sunlit waves, is due to these complex motions. The dancing, sparkling points of light are one of the great charms of a shore which faces the sun. When the early riser sees the sunlight sparkling on the summer sea, and goes out into the freshness of the new day, he knows, as few others know, the true joy of the morning. When the sun first appears above the sea a narrow lane of

ruddy light stretches from the horizon to the shore. As the sun rises higher the band of light broadens out, but ceases to be continuous. As day advances we no longer recognize a band of light, but see the intermittent flashing of the image of the sun from all parts of a broad stretch of sea. Between the observer and the sun the light is caught and reflected, as from a mirror, by the sloping flanks of the waves which are travelling towards him. For a long distance on either hand sideway undulations heave the water to such a slope that the heliographic flash is seen by the same observer. Distance and the quickness of extinction make it difficult to realize that this appearance, so like the quick flashings from the facets of a diamond, is really an image of the sun. Sometimes, however, in slowly heaving water, and when the light is not too strong, the sun's disc may be distinguished in multitudinous repetition. I have noticed this effect very distinctly in the Serpentine when the light of the sun has been suitably reduced by a *soupçon* of London fog. I have also noticed a beautiful effect, somewhat of the same class, on looking down from Beachy Head when a light mist concealed the surface of the sea, which, however, was momentarily revealed by heliographic flashes from the waves.

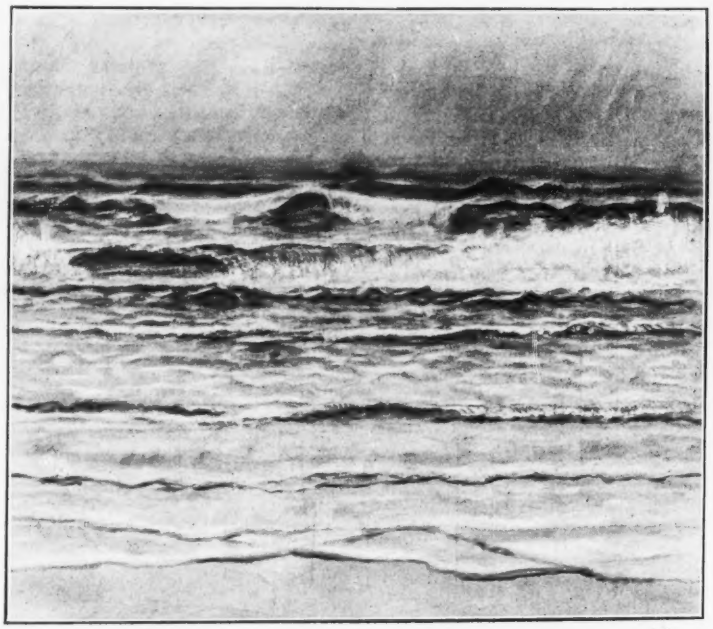


Fig. 3.—Waves breaking on a Flat Shore.

We have explained the deflection of the wave crests which causes the rollers to travel in opposite directions upon opposite shores of a bay. But why does the sea always break upon the coast, even when the wind is dead off shore? One would naturally expect that, if the wind continued to blow off shore for a sufficient time, the waves would run *from* the shore; and in point of fact we know that, if we set out to sea in an off-shore wind, we should find, after going a certain distance, that the waves *are* travelling away from the shore. Again, if we look at a small sheet of water, such as a pond, when agitated by the wind, we observe that there are breakers on the leeward but *not* upon the windward shore. The following may serve as a tentative explanation of the anomaly. The motion of a wave depends upon two things: first, upon the action of the wind upon it; secondly, upon the impulse received from other waves. Quite close to the beach the impulse from other waves cannot act seawards, for the other waves are all upon the seaward side. Again, the power of an off-shore wind to raise the waves at the margin of the sea is no greater than at the edge of a small pond; and we know that the most powerful wind can raise but a very small wave at the windward edge of a pond. If, therefore, there be present any agitation of the sea other than that due to the off-shore wind, there exists no agency close to shore adequate to prevent this agitation from sending in waves and forming a breaker. As a matter of observation the turbulence of the sea is so persistent that agitation from past winds or other causes never seems to be wholly absent. This persistent turbulence of the sea we shall be able to explain to some extent in our next article.

In order to observe the forms and motion of the waves the learner should not seek the tumultuous surgings on a rocky coast, but should rather go in quiet weather to a flat shore, and walk by the furthest edge of the beach at low tide. The most favourable conditions are when the waves break upon a shoal about a gunshot from the shore, and when a ridge or bank of sand or shingle terminates the beach. Then the incoming wave breaks upon the shoal, and the low foaming ridge of the "solitary" wave traverses the strip of shallow water, at the edge of which the foam disappears as the waves once more assume the usual form. A group of these, of shorter length from crest to crest, makes for the shore, where the second (smaller) breaker discharges itself upon the ridge of sand, from which a reflected wave travels back, meeting the next incoming wave, with which it seems to struggle for a moment; then each passes through the other, the one hurrying seawards, the other making its way to shore. These and other intricacies of wave motion may here be seen, best of all when the slanting rays of the setting sun mark front and rear of each smallest wave with a double line of light and shadow.

On the other hand the *force* of waves is most strikingly shown where the sea bursts over rocks or breakwaters, as shown in our full-page illustration. We return to the subject of the "Force of Waves" in our next article.

ANTARCTIC EXPLORATION.

By William S. Bruce, *late Naturalist to Antarctic Expedition*, 1892-93.

POLAR exploration, and more especially South Polar exploration, is the first problem to-day among the geographers of the world. At present there are no less than three North Polar expeditions in the field, Norway, America, and Britain each having a representative in the northern world of ice. It is not our intention, however, at present to deal with these northern expeditions, but, in passing, we must wish them success.

Of the three, perhaps Nansen's and Peary's are of the greatest interest: the one for the boldest, and indeed the most ingenious, dash ever made at the Pole, headed by a man whose Norse blood and sound scientific reasoning gives us the keenest belief that he will accomplish more nearly, if not entirely, the aim of so many of his predecessors; the other because we know that it is headed by a man who has done one of the most solid pieces of Arctic work yet accomplished. We Britons, too—do we not watch with eager interest the work of our countryman Jackson, who will, we feel confident, give us results which not only we, but the whole world, will be proud of? Wellman, too, we trust, will have better fortune next season; and Andrée's unique resolve we hope will be profitable to science.

In looking at the history of Polar exploration, the one thing that strikes us is the immense amount of work done in the north compared with that done in the south; and the reason is not far to seek. The object of early Arctic navigation was not to reach the Pole, but to discover a shorter route to India by the North-East and North-West Passages; then there was the additional interest which Russia and Britain had in delineating the northern coasts of Europe, Asia, and America; and, beyond this, the desire to penetrate the unknown simply for the sake of gaining knowledge of it. "And to what avail?" it is said. To what avail! See the fleets of whalers and sealers leaving Norway and Britain year after year, bringing home the richest cargoes in the world. Behold, also, the wealth of Siberia opened up to the great trading nations of the world. But, more than this, consider the rich treasures that science has gained, and the romance—the heroism—these adventures have called forth.

The history of the North Polar regions fills volumes, but it is easy to give a brief outline of the history of the South Polar regions. To Peru belongs the honour of sending out the first Antarctic expedition, more than three centuries ago. In 1567 the Governor sent out an expedition under the command of his nephew, Alvaro Mendaña, to discover "Terra Australis Incognita;" and a second Peruvian expedition was sent out in 1605, and discovered an island of the New Hebrides group in 1606.

Dirk Gorrits, in the meantime, in 1598, had set sail from Amsterdam accompanied by a small fleet; and, being separated from his companions by heavy weather, near the Straits of Magellan, discovered some high land now known as the South Shetlands. Gorrits and his crew were eventually captured by the Spaniards. France was next in the field, La Roche discovering the island of South Georgia in 1675; and Kerguelen, in 1772, saw what he at first believed to be the Antarctic continent, but returning in the following year he found it to be only a small island. This island now bears his name. Britain, however, was the first nation to do any real work in the Antarctic, and that work is associated with the name of Captain Cook. He was the first to cross the Antarctic Circle in 1773, and, crossing it again in 1774, he attained as high a latitude as 71° 15′ S. In a second voyage he circumnavigated the globe in high southern latitudes, twice crossing the Circle, and was thus the first to confine the southern continent within the Antarctic Circle. Cook described the terrors and inhospitality of these regions, and firmly believed that no higher southern latitude would ever be attained. In 1819, William Smith, of Blyth, re-discovered the South Shetlands, the discovery being confirmed by Bransfield in the following year, who also sighted Bransfield Land. In 1820 the Russian Bellinghausen crossed the Antarctic Circle, and attained the latitude of 70° S. in 1° 30′ W.; he discovered Peter and Alexander Islands, then the most southerly land known. In the following year Powell discovered the South Orkneys. In 1823 our brave and distinguished countryman, Captain James Weddell, exceeded all former records, sailing as far south as 74° 15′ S. in 34° 17′ W. Here, on the 20th of February, he found a sea clear of field-ice, with only three icebergs in view.

John Biscoe, in the service of Messrs. Enderby, was the first to put foot on land within the Antarctic Circle; this was on Adelaide Island in 1831. It was he who discovered the western coast of Graham's Land, the Norwegians and ourselves first seeing the eastern coast in 1893. Several other masters sailing under Messrs. Enderby made discoveries, notably Balleny, who discovered Balleny Islands and Sabrina Land. After these, D'Urville the Frenchman, Wilkes the American, and Ross our own countryman, during the years 1839-43, can alone be classed as Antarctic explorers. The *Challenger* paid a flying visit in 1874, and in 1892-3 Norway and Scotland despatched a whaling fleet to which was attached a scientific staff. And Norway has been again to the fore in the last two seasons, Captain Larsen, of the *Jason*, having added very considerably to our knowledge of the eastern coast of Graham's Land; while Captain Svend Foyn's vessel, the *Antarctic*, has this year reached the latitude of 74° S., the highest attained since the time of Ross. A party from this vessel, led by Mr. Borchgrevink, had the good fortune of being the first to land upon the mainland discovered more than half a century ago by our own countryman, Sir James Ross.

But of all the expeditions to the Antarctic regions that of the *Erebus* and *Terror*, under the command of Sir James Clark Ross, during the years 1839-43, is by far the most important. With the most indomitable courage and perseverance Ross crossed the Antarctic Circle in three successive years. On two of these occasions he attained far higher latitudes than any of his predecessors. He discovered Victoria Land, the vast mountainous tract extending away to 78° S., in the longitude of New Zealand, terminating with Mount Erebus, which, from a height of over twelve thousand feet, lights up the winter darkness of the snowy desert. From this point in about 78° S. he sailed along an icy barrier running eastward for three hundred miles, the termination of the ice-cap of the great Antarctic continent. In 1842-43 he visited the region of Erebus and Terror Gulf, lying to the south of Cape Horn, and became entangled in impenetrable pack; pushing farther eastward, he again crossed the Circle, attaining a latitude of 71° 31′ S., between Bellinghausen and Weddell's tracks. Ross believed he could have landed and travelled over the continent, and had he had steam he would undoubtedly have accomplished what with a sailing vessel was quite impossible.

D'Urville and Wilkes both did good work, and discovered land south of Cape Horn and south of Australia in high southern latitudes.

And now it is suggested that these wintry realms should again be thrown open to scientific investigation, and the cry "*Cui bono?*" has once more to be encountered. But let us frankly confess at the outset that we do not intend to lure on half-hearted supporters with the hope that such an expedition may lead to any monetary gain, although new channels for our commercial energy have been opened up in other parts of the world where, not commerce, but religion, science, and adventure have urged men and women to fathom the unknown. We go forward as eager enquirers, seeking to discover new truths and beauties which nature is ready to reveal to us.

No other part of the world offers a wider field for original research than the South Polar regions, and it is astonishing

to one who has had the least practical acquaintance with that part of the globe that more enthusiasm for their exploration has not been shown. Take, for instance, meteorology. The only meteorological records we have of the Antarctic regions are during the three or four summer months; and although we may meet with many charts which picture the meteorological conditions of these regions, yet these, even for the summer, are almost purely theoretical. There are no records of any fixed station south of the latitude of Cape Horn even for the summer months. Our practical knowledge of the terrestrial magnetism of even moderately high southern latitudes is really only gathered from Sir James Ross's investigations, which, excellent as they are, can hardly be said to give us an accurate idea of the present magnetical conditions of these latitudes and the sequence of changes that have taken place during the last half-century. Now, apart from all other investigations, it is of vital importance to us, as the greatest seafaring nation, that our knowledge in these two branches of science should be extended in the south, for without doing so it is impossible to have any complete summary and classification of the laws which govern the meteorology and magnetism of the world. This meteorological and magnetical work can only be done by landing several parties, who shall set up fixed stations for the whole year at different points on the islands and mainland of Antarctica, and who shall thus be able to carry on observations systematically, not only during the summer, but also during the winter months. If possible, these observations should be extended into a second and even a third year, so as to note more completely the regular sequence of events. Besides having these stations, at various other points recording instruments should be set up and the results noted summer after summer. Wintering in the Antarctic has been much dreaded by many, but perhaps the task would not be so trying as in the north, provided, at least, that the wintering stations were not far within the Antarctic continent.

It must be remembered that there is an entirely different distribution of land and water in the south to that which occurs in the north. In the north we have a Polar basin—a Polar sea more or less dotted over with islands—surrounded by the continental ring of Europe, Asia, and America, broken only at two main points by the Greenland Sea and Behring Straits; in the south, probably a Polar continent, surrounded by the great Southern Ocean. In the north, then, we have, even in the highest latitudes, all the ameliorating conditions of a continental summer—bees humming their merry tune and flowers decking green valleys where musk oxen graze; but we have also all the rigours of a continental winter, enabling the Franklin expedition to register as much as ninety degrees of frost, and others even greater degrees of cold. In the South Polar lands (except, perchance, in the heart of the great continent) we have to deal with an oceanic climate, where the variations between winter and summer are very greatly diminished; and although during the summer we may seldom, if ever, have the thermometer rising above the freezing point, yet in the winter the thermometer should not register such extraordinary degrees of cold as in the north. But here, again, our statements are based on theory; the more important, therefore, is it in the near future to make a clear statement of facts from the result of observations.

It is plain that in meteorology and terrestrial magnetism we have two subjects not only of purely scientific interest, but of vast importance for the more accurate navigation and greater safety of our vast fleets throughout the world. There is one other subject which combines scientific and commercial interest, and that is biology. How far is it possible for us to prosecute seal and whale fisheries, and what must be the conditions of administrative protection? The commercial expeditions of the last three years from Norway and Scotland seem rather to indicate that these fisheries cannot be profitably prosecuted, but still we must acknowledge that there has been hardly sufficient investigation to answer this question decisively. The discovery of guano at Cape Adair by Mr. Borchgrevink also opens up a new channel for commercial enterprise. But, apart from the commercial aspect, a very rich biological field lies waiting for us in the Antarctic. Sir James Ross gathered many invertebrate treasures, but these, unfortunately, mostly perished without ever being properly examined. The *Challenger* was more successful, and Dr. Murray has brought to light some very interesting relationships in the similarity of the fauna of the South and the North Polar seas. In order to carry on this interesting and valuable research, it is necessary to equip an expedition which shall dredge, trawl, and tow-net throughout the breadth and depth of the great Southern Ocean. Unfortunately, the *Challenger* was not an ice-protected vessel, and it would have been unwise for her commanders to have carried on further research than they did in such high southern latitudes. Beyond the mammalian and invertebrate fauna, there is also the vast host of birds and fishes to be studied, about which we know next to nothing. Botanically we cannot hope for much, except possibly in marine algæ. It is interesting to note, however, that Mr. Borchgrevink, of the *Antarctic*, found this year on Possession Island a lichen. This is the only recorded land plant found within the Antarctic Circle.

Towards the bathymetrical survey of the Southern Ocean both Ross and the *Challenger* contributed valuable observations, and the *Challenger* observations have been lucidly expounded by Dr. Murray, who has brought to light many very interesting facts regarding the distribution of oceanic deposits. But only the borderland of this new world has been touched, and there still remains a vast field of most interesting and important scientific research. As a result of these investigations Dr. Murray has defined to us what must be more or less the outline of Antarctica, and it is consequently of more interest than ever that a practical survey of this coast-line should be made. There has always been a theory of an Antarctic continent, but Dr. Murray's theory differs from all previous ones, inasmuch as it is founded on fact.

To Captain Larsen, of the *Jason*, who has recently been awarded the Back Grant of the Royal Geographical Society for his valuable Antarctic researches, do we owe the first concrete addition to our knowledge of the geology of the Antarctic. He has landed several times, being the first who ever travelled over the Antarctic ice, and on one or more of his landings secured a most interesting set of fossils. Still, this is only a beginning in the geology and palæontology of the south, and the geologist is enthusiastically eager for further research. Geodetic problems, problems of the Great Ice Age, of oceanic temperature, salinity, and circulation, and other branches of scientific knowledge too numerous to be mentioned here, have to be studied. Such, briefly, is the work of a modern Antarctic expedition.

Since the return in 1893 of the Norwegian and Scottish whalers there has been an endeavour among scientific men and societies to promote a British Antarctic expedition, but more than two years have elapsed and yet no definite plans are on foot. But outside our islands scientists have met with greater success. Dr. Cook leaves New York next year, and possibly two other countries will

be despatching Antarctic expeditions. Is the British nation not to be moved? Are we, the maritime power of the world, to stand by and look on while other nations solve the problems of oceans? Much can be done by private enterprise, and such enterprise should be fostered; but if we have our old enthusiasm we can do something more than send out a private expedition from our shores. The scientific world is at present ringing with the praises of the *Challenger* expedition. Do we regret having sent out that expedition? Has it not made Britain a greater maritime nation than she ever was before? Does Cook's work from east to west, from north to south, count for nothing? Do we regret having the names of Weddell, Ross, Franklin, and a hundred others added to our roll of heroes? Let us show that we are still the leading maritime power of the world, and that in peace our victories are even greater and more lasting than in war! Let us unite together again, and add another chapter manifold richer than the chapter of the *Challenger*, since by that expedition we should have learnt how to carry on a similar piece of work to even a more successful conclusion.

We do not in the least advocate that such an expedition should ever attempt to reach the South Pole. A rush to the Pole is not what we desire, but a systematic survey of the whole South Polar regions, and a continuous series of various observations throughout at least two, if not three, years. There is no doubt that such an expedition would furnish inconceivably valuable results, and that a new gem would be added to our nation's records. Even greater would be the glory and the final results if the Antarctic regions were to be explored by the co-operation of the great nations of the world; and it is pleasing to record that the International Geographical Congress has unanimously adopted the following resolution recommended by a most distinguished committee, consisting of Sir Joseph Hooker, Dr. John Murray, Dr. Neumayer, Professor Von den Steinen, and M. Bouquet De la Grise, namely:—

"The Sixth Geographical Congress, assembled at London, 1895, records its opinion that the exploration of the Antarctic regions is the greatest piece of geographical exploration still to be undertaken; and in view of the addition to knowledge in almost every branch of science which would result from an expedition to the South Polar regions, Congress recommends the several scientific societies throughout the world to urge, in whatever way seems to them most effective, that this work should be undertaken before the close of the century."

Surely the unanimous resolution of so great an assembly will have sufficient weight to move the most retrenching Governments to tread onwards, and

"To grace this latter age with noble deeds."

NOTE.—The Governments of New South Wales and Tasmania have recently agreed to raise funds for an Antarctic expedition if the other Australian Colonies will also join the project.

SIR WILLIAM HERSCHEL. From *The Herschels and Modern Astronomy.*

Notices of Books.

The Herschels and Modern Astronomy. By Agnes M. Clerke. (Cassell & Co.) 3s. 6d. The subject of Miss Clerke's latest work is not a new one to her, as she had largely treated of the Herschels in her "History of Astronomy in the Nineteenth Century," and had there shown how strongly the subject had excited her interest. With a writer of Miss Clerke's force and charm of expression, and deep and thorough sympathy in her subject, the book before us could not fail to be one to commend itself to every reader to whom astronomy at all appeals, or who can be attracted by the narration of the final success of genius. The author tells us in the preface that the gleanings about William Herschel's scientific works, apart from those taken directly from Caroline's "Journals and Recollections," have had to be sought and studied one by one in the various volumes of the *Philosophical Transactions.* Very naturally the subject divides itself into three parts, which tell in turn of William, Caroline, and John Herschel. The life of William Herschel is still more an account of the birth and first beginning of our present-day observational and physical astronomy. When the elder Herschel tried fitting lenses into pasteboard tubes, in 1772, and obtained but poor results, these sections of the divine science were non-existent; the idea of their possibility, even, had not germinated in men's minds. In sentences that charm the reader by their power and completeness, Miss Clerke narrates how the musician of Bath designed "to carry improvements in telescopes to their full extent" and "leave no spot of the heavens unvisited," and how he trained his senses of sight and touch to render possible the accomplishment of his great design. After *two hundred* failures a tolerable reflecting telescope was produced, about five inches in aperture and of five and a-half feet

focal length. The outcome may seem small for so great an expenditure of pains, but those two hundred failures made the octagon chapel organist an expert. But the most interesting chapter is that one which deals with "The Influence of Herschel's Career on Modern Astronomy." Of Sir John Herschel there is a chronological table of successes. "His life was a tissue of felicities. For him there was no weary waiting, no heart-sickening disappointment, no vicissitudes of fortune, no mental or moral tempests." He was a physicist, poet, chemist, mathematician; he was also an astronomer. There is never need to dilate on Sir William Herschel's genius; the fact is self-evident. Miss Clerke insists again and again that Sir John was a great man; that he stood "supremely at the head of the list"; that he was a successful man. The impression remains that it was his very success that was a failure; that if the hill of pre-eminence is smooth, it offers small grip to the foot of the climber. Sir John worshipped many gods: his father, but one.

The Cell; Outlines of General Anatomy and Physiology. By Dr. Oscar Hertwig. Translated by M. Campbell, and edited by Dr. H. J. Campbell. (Swan Sonnenschein.) Illustrated. 12s. "The cell theory," remarks Prof. Hertwig, "is the centre around which the biological research of the present time revolves." The theory that organisms are composed of cells was first suggested by the study of plant-structure, and the term "cell" was applied to the small room-like spaces, provided with firm walls and filled with fluid, to be seen in plants. Both Schleiden and Schwann (1838) believed the cell to be a small vesicle, with a firm membrane enclosing fluid contents; but, later, Max Schultze (1860) defined it as a small mass of protoplasm endowed with the attributes of life. Improved means and methods of observation have shown that this conception must give way to a better, and the definition now held is that the cell is a little mass of protoplasm, which contains in its interior a specially-formed portion, the nucleus. It is around this nucleus that biological investigations are now mostly centred; its nature, functions, changes, and potentialities will form the subject of work and discussion for many years to come. In fact, upon the nucleus is now concentrated the attention that in earlier days was given to the cell. The cell is very uniform in appearance throughout the animal and vegetable kingdom, and contains the key to many problems of life, while its relations to the protoplasm in which it is embedded are of absorbing interest. Prof. Hertwig is recognized as one of the greatest authorities on cell-structure, and this accurate translation of his treatise on the subject will be heartily welcomed by those who do not read German fluently, and yet desire to learn what is known about the "ultimate particles" of life. The historical course of the development of the more important theories relating to the cell is traced, and the knowledge gained by means of microscopical, chemico-physical, and other methods of inquiry is clearly set down. Few works are more valuable to students of histology than this, and in none will a better account be found of the nature and attributes of the cell-organism—that little universe the mysteries of which are slowly being unravelled. Prof. Hertwig is happy in having such an excellent translator and careful editor as those to whom the English version of his work has been entrusted.

British Fungus-Flora. By George Massee. Vol. IV. (George Bell & Sons.) 7s. 6d. This is the fourth volume of a standard text-book of mycology, written by a recognized authority on the subject. In it the species of fungi included in those families of the large natural order of the Ascomycetes are classified and described. Acting on his opinion that "no one can be considered to know a species thoroughly until it has been worked out by himself," Mr. Massee has personally examined type specimens in all cases where they were accessible (his position at Kew giving him exceptional opportunities for doing so), and has thus been able to make his descriptions of the characters of species full and trustworthy.

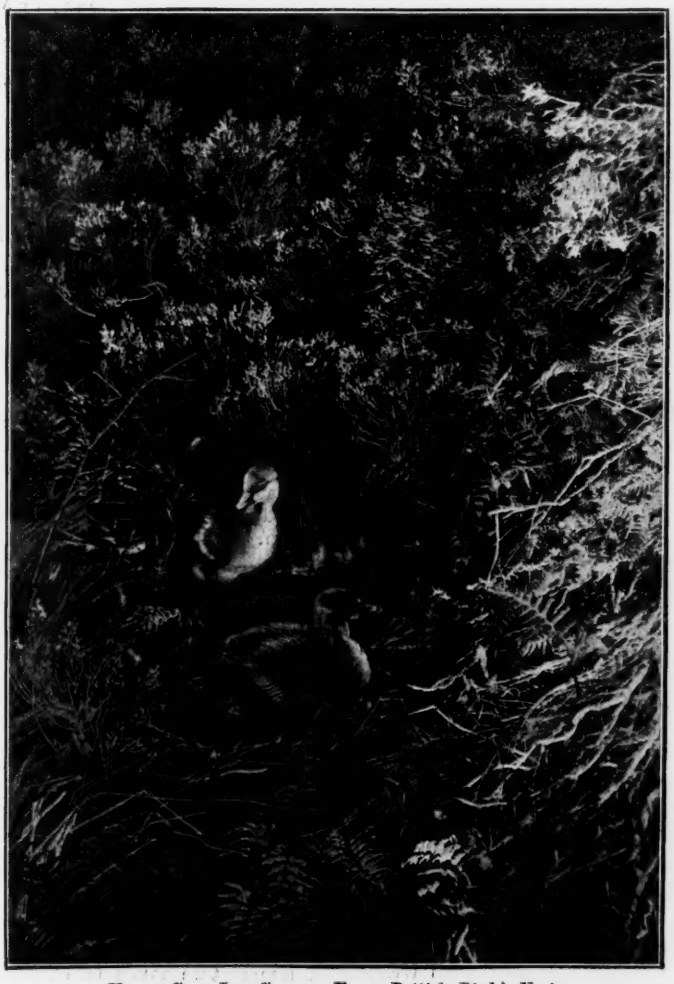
Simple Methods for Detecting Food Adulteration. By John A. Bower. (London: S.P.C.K.) Mr. John Bower chooses as his text the well-known words of Tyndall: "Apply the principles of science, and make them available to the needs, the comforts, and luxuries of life." This he has very indifferently succeeded in doing in the present volume, which is full of the most glaring errors, and gives such trivial tests for adulteration that those who endeavour to follow them will find that their efforts are thrown away. When we mention that we find such slovenly expressions as "the precipitation of the lime" on boiling hard water, that silver nitrate gives a white precipitate with the "organic impurities" in water, and that a "serviceable filter" can be made out of a flower-pot and some sand and magnetic oxide of iron, our readers will see that this adverse criticism is well deserved.

The Scientific Foundations of Analytical Chemistry. By W. Ostwald. Translated by G. McGowan. (Macmillan.) Prof. Ostwald's work during the last ten years on the borderland of chemistry and physics has naturally led him to look upon routine analytical work in the laboratory as almost devoid of any scientific basis. And in this respect we are fully in agreement with him. In scarcely any of the text-books do we find any mention of theory, and in the majority of examinations the practical work can be passed by a clever student who crams up a set of analytical tables. No student could pass a practical examination by reading Prof. Ostwald's book, but any one who has read it carefully through, and proved the different reactions in the laboratory, would have a real knowledge of practical chemistry. To the older student the work appeals, as it throws new light on many reactions which seem at first sight to be unique and uninfluenced by any general laws. We hope that all teachers will endeavour to frame their instruction on the lines laid down by the author, so that practical chemistry may cease to be simply the art of test tubing.

Text-Book of the Embryology of Invertebrates. By Dr. E. Korschelt and Dr. K. Heider, Translated from the German by Dr. E. L. Mark and Dr. W. Mc M. Woodworth. Part I. (Swan Sonnenschein.) Illustrated. 15s. Students of animal morphology well know the great value of the *Lehrbuch* of which this is a translation. To be able to read the work in English will, however, be a boon to many zoologists who find the perusal of the German text a rather laborious task. And even to those who have no difficulty in reading the original work the translation will be valuable, for numerous additions, recounting the most important results arrived at by embryologists since the date of first publication, have been made by Drs. Korschelt and Heider, and appear for the first time in the present edition. The complete work is published in three parts, and the first of these deals with the Porifera, Cnidaria, Ctenophora, Vermes, Enteropneusta, and Echinodermata. It is the translation of this part that is now before us, and we are glad to notice that translations of Parts II. and III. are in preparation. German men of science have a wonderful faculty for collecting knowledge, and the present volume is a good example of what they can do in that way. Practically all the literature of comparative embryology appears to have been consulted in the preparation of the work, and both students and special

investigators will find the volume contains the best modern treatment of their subject.

Handbook of Industrial Organic Chemistry. By Dr. S. P. Sadtler. 2nd Edition. (Lippincott.) The first edition of this handbook was well received in this country, and supplied a gap in the existing literature. During the four years which have elapsed since the first edition was published, England has produced several books dealing with industrial organic chemistry, so that the want is hardly so acutely felt now as formerly. The literature has, however, been more of special character than of the general description covered by Dr. Sadtler's book; and as he has taken considerable pains in incorporating the recent progress made in the several departments, we think that the new edition will be welcome to many chemists. Dr. Sadtler's book is especially valuable for the statistics which it contains of the world's production of raw materials and their finished products; and as he has also completed each section of this work by a bibliography of the special works of reference, the reader has afforded to him information which will enable him to further study any special point. The methods of analysis given by the author are, however, frequently wanting in details. His method of procedure seems to have been to abridge and abstract the information contained in "Allen's Commercial Organic Analysis." The section devoted to vegetable textile fibres is well written, and gives a good *résumé* of the important industries connected therewith; and under "Animal Tissues and their Products" is a good general account of the leather industry and the allied manufactures of glue and gelatine.



Young Grey Lag Geese. From *British Birds' Nests.*

Outlines of Psychology. By Prof. Oswald Külpe. Translated from the German by Prof. E. B. Titchener. (Swan Sonnenschein.) 10s. 6d. The science of psychology can be divided into two main branches: the first is the descriptive and metaphysical branch, which dominated it for ages, while the newer movement is experimental and psycho-physical. Prof. Külpe's work is concerned with investigations in the latter direction. In this country psychology is not given so much attention as in Germany and America, but the number of its students is gradually increasing. Doubtless this translation of a work by one of the foremost investigators of the modern school will give an effective impulse to the study of the science with which it deals. Kant shared with others the view that there could not be an exact science of psychology; but their opinions are refuted by the fact that physiological psychology, or psycho-physics, has established important propositions capable of exact mathematical treatment, whereas Kant argued that mathematics could not be applied to conscious processes. There is certainly an increasing demand for psychological literature at the present time; and though the supply is now kept up mostly by translations from the German, it is to be hoped that the future will see larger contributions from British workers.

A Laboratory Manual of Organic Chemistry. By Dr. Lassar-Cohn. Translated by Dr. A. Smith. (Macmillan.) 8s. 6d. We are very pleased with this guide to practical organic chemistry; it certainly fills a gap in our English chemical literature. Nearly five years have elapsed since the publication of the first German edition, and during that time this most useful work has met with a warm reception among German chemists, and has been introduced as a standard manual into most of the university laboratories and polytechnics in Germany. This success is undoubtedly due to the very systematic method adopted by the author of arranging the several methods of chemical operations into distinct chapters, and giving such practical working details that even the novice need not go far astray when performing a new task. We hope that the book in its English edition will meet with a similar reception both in this country and America, as the translator has performed his duties in an exemplary manner, and has further enhanced the value of the book by his rearrangement of the index.

British Birds' Nests. By R. Kearton. With an Introduction by R. Bowdler Sharpe, LL.D. (Cassell.) Illustrated. 21s.

XUM

The originality of the illustrations in this book commends it at once as a work of exceptional interest. The text consists merely of dry but careful descriptions of the nests and eggs of the birds which breed in the British Isles, and where they are to be found. It is true that the author's object is to teach "how, where, and when to find and identify" these nests; but we think that he has made a very great mistake in not recounting more of the many adventures and experiences which his brother and himself must have met with in procuring the many beautiful photographs contained in the volume before us. The advantages of the camera as an aid to the naturalist have never been better illustrated than in Mr. Kearton's book. The nest or eggs of almost every bird that is to be found breeding in the British Isles are here portrayed in their original position, just as they were found amidst their natural surroundings. What could be more useful to the ornithologist, or more interesting to those who never have seen, and perhaps never will see, the actual thing? Beyond this, many of the photographs are beautiful pictures, which will be admired and appreciated by those of artistic tastes. By courtesy of the publishers we are enabled to reproduce one of these illustrations. The photography of birds in their native haunts, their nests and eggs, must always be attended by a great deal of labour, difficulty, disappointment, and even personal danger; and we think that Mr. Kearton and his brother have achieved a great success in obtaining such a splendid collection of photographs.

SHORT NOTICES.

Hidden Beauties of Nature. By Richard Kerr, F.G.S. (R. T. S.) Is a well-illustrated work and forms an excellent introduction to microscopical study. Mr. Kerr unfolds in simple language the marvels and beauties of many forms of life overlooked by most and studied by few. It is hoped that the perusal of this book will induce many to study the microscopical world around us.

Garden Flowers and Plants. By J. Wright, F.R.H.S. (Macmillan.) Illustrated. This little manual will be found of great practical use to amateurs in raising and growing plants and flowers in town, suburb, or country. Each plant is treated separately, and the book is provided with a good index.

Nature's Story. By H. Farquhar, B.D. (Oliphant, Anderson, & Ferrier.) Illustrated. Is written for young people. The author has been very successful in explaining, in a series of brightly written essays, many interesting and instructive scientific facts. The book is eminently fitted for the young, and will bear perusal by many older persons.

Analytical Key to the Natural Orders of Flowering Plants. By Franz Thonner. (Swan Sonnenschein.) To students of exotic floras this little book will prove of great value in extending their knowledge of the subject, and especially in determining the various orders to which the vast number of these plants belong.

An Introduction to the Study of Rocks. (British Museum, Mineral Department.) This useful book gives, from a Museum point of view, a simple sketch of the relationships of rocks, indicating all the more important characters and pointing out their significance.

A Popular Handbook to the Microscope. By Lewis Wright. (R. T. S.) Illustrated. So many books have been written on the microscope, how to work it, and on what is to be seen by its aid, that we need only commend this book to our readers as very reliable and well up to date.

Whittaker's Almanack for 1896 is as complete and full of useful information as possible, and should be possessed by everyone.

Elementary Trigonometry. By Charles Pendlebury, M.A., F.R.A.S. (Bell & Sons.) Will be found of great service to mathematical students, and especially to candidates for military examinations.

An Elementary Text-book of Mechanics. By W. Briggs, M.A., and G. H. Bryan, M.A., F.R.S. (Clive.) Is one of the University Tutorial Series, and affords beginners a thorough grounding in dynamics and statics. Mathematical formulæ have been avoided as far as possible in this book, in order that the fundamental principles of mechanics may be fully grasped.

BOOKS RECEIVED.

British and European Butterflies and Moths. By A. W. Kappel, F.L.S., F.E.S., and W. Egmont Kirby, L.S.A. (Nister.) 25s.

Ethnology. By A. H. Keane, F.R.G.S. (Cambridge University Press.) Illustrated. 10s. 6d.

Leisure Readings. By E. Clodd, A. Wilson, T. Foster, A. C. Ranyard, and R. A. Proctor. New Edition. (Longmans.) Illustrated. 3s. 6d.

Our Household Insects. By E. A. Butler. (Longmans.) Illustrated. 3s. 6d.

Cock Lane and Common Sense. By Andrew Lang. New Edition. (Longmans.) 3s. 6d.

Furs and Fur Garments. By R. Davey. (The Roxburghe Press.) Illustrated.

Minerals: British Guiana and its Resources. By the Author of "Sardinia and its Resources" (Philip & Son.) Cloth, 2s. 6d.; paper, 2s.

Popular Telescopic Astronomy. By A. Fowler, A.R.C.S., F.R.A.S. (Philip & Son.) Illustrated. 2s.

The Story of the Solar System. By G. F. Chambers, F.R.A.S. (Newnes.) Illustrated. 1s.

The Preceptors' Junior French Course. By S. Barlet. (Relfe Bros.) 1s. 6d.

The Koh-i-Núr Diamond. By E. W. Streeter, F.R.G.S. (Bell & Sons.) Illustrated.

Minerals, and How to Study Them. By E. Salisbury Dana. (New York: Wiley & Sons.) Illustrated.

Letters.

[The Editors do not hold themselves responsible for the opinions or statements of correspondents.]

THE CONNECTION OF ASTRONOMY WITH GEOLOGY.

To the Editors of KNOWLEDGE.

SIRS,—A journal like KNOWLEDGE, which deals with both sciences, affords the best medium for discussing the relations between astronomy and geology. My practical acquaintance with the latter science is very limited, being almost confined to the remarkable cavernous limestone district in the counties of Mayo and Galway, of which but little seems to be generally known. Englishmen know more of Adelsberg than of Aylemore or Cong. But let that pass. My object is to point out that geologists have not sufficiently availed themselves of the results of astronomical research, and perhaps a corresponding remark may apply to astronomers.

One point of connection between the two sciences was brought under the notice of the public by the late Dr. Croll, who inverted the earlier but less known theory of the late Mr. Joseph John Murphy. I am not satisfied that either theory affords an explanation of the Ice Age, but undoubtedly effects must have been produced on the flora and fauna of all extra-tropical regions which the geologists should be able to trace. On the assumption of no permanent ice-cap, a period of maximum eccentricity and winter aphelion must have produced a cold winter and a hot summer, and a continuance of hot summers and cold winters must have modified both animal and vegetable life. The phenomena which depend on mean temperature would be little altered, but those which depend on the extremes of temperature would be extensively changed. There is, I believe, in most animals, and probably plants, a principle of adaptation which would enable them to survive the change. This is the principle which Darwin described as the "survival of the fittest;" but the fact appears to be that even the individual animal can to a large extent adapt itself to the surrounding circumstances, as the winter's cold causes the hair of the horse or cow (that is not housed) to grow long. Of course, it may be said that the most adaptable animal is among the fittest to survive—that on the refrigeration of the climate the animal whose hair became long was as fit as the animal whose hair was long originally. But while I prefer my own term, the point on which I insist is that the changes relied on by Croll must

have profoundly altered the climate and left traces on the flora and fauna of the period. A similar remark applies to the case of a maximum eccentricity and a summer aphelion. The mean temperature would be little altered, but the extremes would approach more closely to the mean. Phenomena of this kind could be best investigated a little to the south of the limit of glaciation; and as we know the date of the last period of maximum eccentricity, the identification of its results would be of use to geologists in all problems relating to the age of the earth and its various formations.

Another theory, started by Prof. G. H. Darwin, seems to me of great geological moment; and here, again, if some of the Professor's results are to be regarded as doubtful, it seems certain that the tides must have been slowly diminishing the velocity of the earth's rotation, and that in early geological times the day must have been considerably shorter than at present. The earth was therefore less heated in the day time, and less cooled at night, and the extremes of temperature which now exist must have been considerably modified. As in the former case the mean temperature would probably be unaltered, and the phenomena which depend on it would be the same as at present; but delicate plants which would now be killed by a cold night might have then flourished in this country.

This is not all, however. The equatorial protuberance of the earth is no doubt due to its rotation, and when the rotation was more rapid the protuberance must have been greater. How, then, was this equatorial protuberance lessened? As far as the ocean extends, the answer seems to be clear—by a flow of water from the equatorial towards the polar regions, and a consequent submergence of the land in the temperate zones both north and south of the Equator. The elevated land at the Equator would be slowly washed away by rivers; but if the earth's crust was thin, equilibrium might be more speedily restored by volcanic outbursts beyond the limits of the tropics. Lava might stream out until the land at the Equator was sufficiently lowered and that in the neighbourhood of the outbursts raised by the operation. Such volcanic outbursts might mask the simultaneous rising of the sea-level in the same localities. These polar ocean-currents would, in the northern hemisphere, take a westerly bend for the same reason that the Gulf Stream does so; and in places where there are no great traces of volcanic action we may expect to find evidence of the sea gaining on the land from the south-west, as appears to be the case, for instance, at St. David's. The effects of this reduction of the equatorial protuberance are, at all events, worthy of more attention than they have hitherto received from geologists. The amount of the reduction is, to a large extent, matter of speculation, but the reduction itself seems to be an ascertained fact.

Whether the nebular theory be accepted or otherwise, most persons will concede that the earth was once too highly heated to sustain life. From this fact, and what we know astronomically about its cooling, some inferences follow as to the early history of the earth which have hardly been recognized. Assuming that, whenever the necessary conditions for sustaining life are supplied, life itself will speedily follow, we can in this way trace the history of life on the earth. The Poles must have cooled faster than the Equator, because they received less solar heat. The earth, therefore, became habitable at the Poles when the Equator was still too hot to sustain life. At this early stage of intense heat a great part, if not the whole, of the water on the earth was in the form of vapour. As the cooling proceeded this vapour first formed two polar seas, which gradually extended towards the Equator as the process of condensing the aqueous vapour went on. The first form of terrestrial life was, thus, marine life in the polar seas. This life must have been capable of existing under a great atmospheric pressure, for the quantity of vapour still suspended over the earth must have been enormous. But some forms of marine life are found under great pressure in the deep sea. This great blanket of vapour no doubt moderated the extremes of temperature in summer and winter, and thus assimilated the polar climate pretty closely to that which now prevails in the tropics. Traces of tropical vegetation in the Arctic regions need, therefore, create no surprise. The only cause of surprise is finding them where they were presumably deposited after the earth had cooled down nearly to its present condition. But we have no reason to conclude that the carboniferous period, for instance, at the eightieth degree of north latitude was nearly contemporaneous with the same period at the fiftieth degree. Life had probably already gone through several stages of progress at the Poles when it made its first appearance at the Equator. The condensing of the vapour in the atmosphere, commencing at the Poles, would proceed gradually towards the Equator, thus inducing a flow of water in that direction. This would be entirely opposed to the flow of water caused by the slackening of the earth's rotation, but both would combine to produce a submergence of the land in our latitudes. The effect of slackened rotation probably continued to a later period than that of the condensation of vapour and its precipitation in rain. Rain, again, must, no doubt, have preceded snow, as liquid water preceded ice.

As to the amount of heat received from the stars, there can be no doubt that it has been different at different times, but it may be doubted whether the difference was sufficient to produce a sensible change in the climate of the earth. Nevertheless, this possible explanation of certain terrestrial phenomena should not be wholly overlooked.

One further suggestion I may make. Suppose an equatorial protuberance composed of solid land is formed by the earth's rotation, and that this rotation subsequently diminishes. It then becomes a great mountain chain, no longer in equilibrium, but subject to a double pull to the north and south. Assuming that the earth has a fluid nucleus, might not this pull, assisted by some irregularities in the shape of the range, lead to one half of the range being pulled to the north of the Equator and the other half to the south, the position of both the Poles and the Equator on the earth's crust being thus displaced? The mountain chain would still form a circle round the earth, but would become inclined to the Equator. I merely throw out this hint for the consideration of those better versed in the subject. The great Pamir Steppe is not far from diametrically opposite to the highest part of the Andes or Cordilleras.

W. H. S. MONCK.

GEOGRAPHY AS A SCIENCE IN ENGLAND.

To the Editors of KNOWLEDGE.

SIRS,—The programme unfolded by Dr. Mill in his article on "Scientific Geography" in your last issue is brilliant but ambitious. I should like to ask what shape his proposal would take, and whether any work on similar lines has yet been done in Great Britain?

GEOGRAPHER.

THE PUZZLE OF "26."

NOTE.—We must express our regret to those correspondents who have sent us further solutions of the ingenious puzzle of "26" that we are unable to insert their communications, in consequence of a request by Messrs. T. Ordish & Co., of 99, Fore Street, London, the publishers of the puzzle, not to disclose any further solutions of it. We have received many solutions, but we do not desire to interfere with the business of Messrs. T. Ordish & Co., even by inadvertence.—EDS.

GREEK VASES.—I.

INTRODUCTORY.

By H. B. Walters, M.A., F.S.A.

AMONG the various branches of Greek archæology the study of vase-painting stands out prominently as of far-reaching interest and artistic importance. Until the last twenty years or so, those who devoted themselves to this pursuit were content to confine their attention to such information concerning the mythology or the religious and private life of the Greeks as might be derived from a study of the subjects depicted, without regard to chronological or technical questions. The discoveries of recent years, however, have brought about a demand for a more scientific method, dealing more with questions of chronological arrangement and classification of the various fabrics and technical processes.

It is a common thing to hear these vases spoken of as "Etruscan," although this term, which arose in the last century, when few vases had been found except in the tombs of Etruria, has now been discredited for many years. It still, however, holds sway with all the tenacity of a popular error, and its use cannot be too strongly deprecated, resting as it does on no grounds whatever. A small number of vases were undoubtedly made by Etruscans in imitation of imported Greek fabrics, but all possess unmistakable characteristics which mark them off from the products of Greek artists. The fact that such a large proportion of the Greek vases which are to be seen in European museums were found in Etruria is due to an extensive system of importation from Greece, which went on during the sixth and fifth centuries B.C., the period to which the finest productions of the Greek potter's art belong. These vases seem to have caught the taste of Etruscan noblemen, who employed them to adorn their houses, and more especially for funeral purposes. Of late years, however, excavations on Greek soil have not only enabled a fine collection to be formed in the museum of Athens itself, but have yielded many examples for the European museums in no way inferior to the masterpieces imported into Etruria.

It may be laid down as a general rule that all these vases have been found in tombs, whether in Greece, Italy, or elsewhere. There are, however, a few exceptions, where excavations on the site of an ancient temple have brought to light large quantities of vases or fragments of vases, often with dedicatory inscriptions to some Greek deity. The most notable instance is on the Acropolis at Athens, where excavations have been recently made in the *débris* caused by the sack of the citadel by the Persians in B.C. 480, and a collection of fragments was found, many of unique beauty or delicacy of execution; these had probably been dedicated in the Temple of Athena, and cast aside as worthless when the sack took place. Other instances are at Naucratis, a Greek settlement in the Delta of Egypt, and in the neighbourhood of Corinth (probably from a temple of Poseidon).

The sites on which vases have been found in tombs are very numerous, and cover a large area. In Italy, Etruria and the southern districts (Campania, Lucania, and Apulia) have yielded large quantities, the chief source in Etruria being Vulci, and in the other districts Nola, Capua, Ruvo, and other less-known places. The vases from the latter are mostly the product of local Greek artists in the great colonies of Magna Græcia. Several places in Sicily, such as Gela and Locri, have also been fruitful in Greek vases. In Greece proper Athens and Attica have yielded the largest proportion, especially of the earlier periods; Corinth and Thebes have produced many of local and of Athenian manufacture. Among the islands, Rhodes, Thera, Melos, and Crete have been most productive, especially of vases of the primitive period; but in Rhodes large numbers of all dates have been found. The pottery of Cyprus is mostly local, and under Phœnician influence; other sites which should be mentioned are Kertch in the Crimea, Naucratis

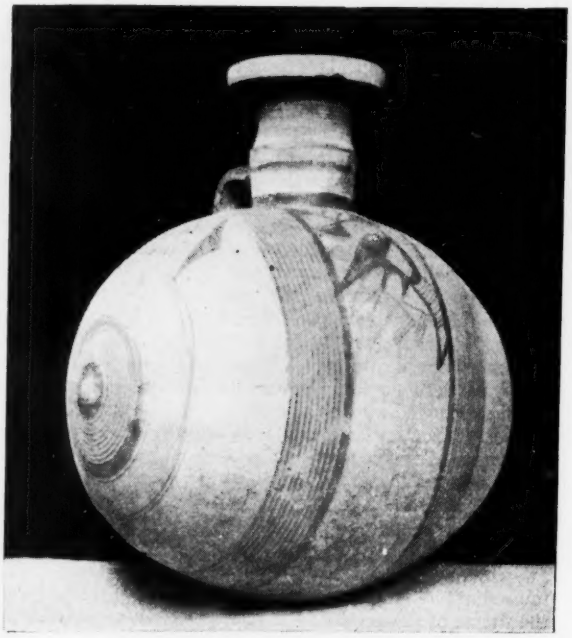


Fig. 1.—Vase from Cyprus.

in Egypt, and the neighbourhood of Cyrene on the north coast of Africa.

The purposes for which painted vases were used by the ancients have been somewhat disputed; but the fact of their being found in tombs tends to show that they must have been largely manufactured for this object alone. As will be shown later on, there are two or three classes of vases which, not only from the subjects depicted on them, but from other evidence, can be proved to have been made exclusively for funerals. The vases were placed round the corpse when it was laid out for burial, and were, no doubt, often filled with oil or fragrant perfumes; afterwards they were placed round the body in the tomb, it being the universal belief of the Greeks, as of other nations, that the dead required in a future existence all the objects of which they made use in their daily life. In some cases the vases appear to have been deliberately broken, with the idea that the dead person could only use what was "dead" also.

In daily life it is probable that the use of painted vases was largely analogous to the modern use of china. The ordinary household utensils, such as drinking-cups, wine-jugs, and pitchers for fetching water, would be made of plain unpainted pottery, while the more valuable and elaborate specimens would be applied to the decoration of the house, or only used on special occasions. Some shapes are obviously adapted for hanging up against a wall; while the fact that on many of the later vases the decoration of one side is markedly inferior to that of the other seems to show that they were placed where only one side was

meant to be seen. Another use of vases was as prizes in the games held at Athens in honour of Athena; this extremely interesting class will be described more at length later.

It will be necessary to say a few words on the methods of construction and decoration, and the materials used therein.

Of the processes adopted for the preparation of the clay we have little information. It was largely obtained from the neighbourhood of Athens and Corinth, which places may be regarded as the centres of vase-making in Greece proper. At Athens there was a regular potters' quarter, known as the Ceramicus; it adjoined the chief burying-place, and was, therefore, convenient for the manufacture of vases for funeral purposes.

The use of the potter's wheel for modelling the clay was known in Egypt in very remote times, and even in Greece was credited with a legendary origin. There are several references to it in Homer, and the vases which are usually referred to his period are certainly wheel-made. It is, however, possible to point to many specimens, especially those of abnormal size, which must have been hand-made. As to whether the wheel was turned by the hand or the foot there seems to be some little uncertainty, but probably the hand was mostly employed.

When the clay had received the required form the surface was carefully smoothed and the vase placed in the air to dry; the handles, which had been made independently, were now attached. The vase was now ready for the baking, one of the most critical processes in the potter's art, owing to the necessity of adjusting accurately the amount of heat required. Frequent instances have come down to us of discoloured vases, which have been subjected to too much or too little heat. Mishaps during the firing were attributed to the malicious influence of evil spirits, and various methods were resorted to to counteract this influence, as we read in a poem attributed to Homer, where the aid of the goddess Athena is invoked against a long list of evil spirits. The ovens for baking seem to have differed little from those in use at the present day. The remains of several such ovens have been found in Italy, Germany, France, and England.

The vase having passed successfully through the process of baking, the next thing was the decoration. As this varied so much in method and extent at the various periods, it will be impossible to give here a general description of the painting processes, which must be treated of later on under the different headings. In most cases a further firing was necessitated to fix the colours, and, this having been done, the vase was regarded as completed.

The study of Greek vases is of little use until the various shapes and the purposes for which each was employed are mastered. Unfortunately, with the space at our disposal, it is impossible to give a complete list of the forms with the illustration of each which would be necessary; but it is to be hoped that a brief description of a few of the principal ones may be of some assistance.

The purposes for which vases were employed by the Greeks may be roughly divided into—(1) for storing liquids or food; (2) for drawing or pouring out liquids; (3) for drinking-vessels; (4) for the toilet, games, or other occasional uses.

Of those included under (1), the *amphora* is the most important and continuously popular: a large jar with two handles and a rather narrow neck; it was used for storing wine in cellars, and also for funeral purposes. The *stamnos* is another variety, with a very short neck and stout body, used for storing wine or food, such as sweetmeats. The *crater* was a vase more especially in demand at banquets, as it was used for mixing wine and water in large quantities; it is a large bowl with wide neck and two vertical handles. The *lebes* is a large bowl without foot or handles, and was placed on a stand or tripod; metal vases of this shape were specially used for boiling liquids.

(2) The *hydria*, or pitcher, is a vase with three handles, generally of considerable size; its use for fetching water from a well is often depicted on vases. The *oinochoë* is in shape equivalent to the modern beer-jug, and was used for carrying round wine at banquets; it was filled from the crater. It was also used in offering libations to the gods. It has many beautiful varieties of form, each with its separate name.

(3) The favourite drinking-cup among the Greeks was known as the *kylix*—a large shallow bowl on a high stem, with two graceful handles. It is, perhaps, the most beautiful shape of all Greek vases, and all the masterpieces of the greatest vase-painters take this form. Other drinking-cups are the *cotylé*, a deep cup with two flat handles; the *cantharos*, a beautiful form of cup with a high stem and two graceful handles; and the *rhyton*, a drinking-horn, the lower end of which was always moulded into the head of an animal or some other form.

(4) Many vases were used for holding oil, whether for the use of athletes in the games or for general purposes; the chief form is the *lekythos*, a straight, slim vase with a very long narrow neck, the object of which was that the oil might pour out slowly. This shape was especially important for use at funerals. The *alabastron* (so called because originally made of that material) and *aryballos* are varieties of the *lekythos*; the latter was used more especially by athletes. Another very common form is the *askos*, so named as being originally imitated from a wine-skin—a small vase, generally supplied with a spout as well as a mouth. The *pyxis*, or toilet-box, should also be mentioned here; it was generally of cylindrical form with a closely-fitting cover, and contained various objects connected with a lady's toilet.

Fig. 2.—Vase from Ialysos.

Thus much having been said by way of introduction to the subject, we will now proceed to treat of it from a

historical aspect, taking the various fabrics, as far as possible, in order of date, and pointing out the special characteristics of each. It may, however, be advisable first to say a few words on the chronology of the different periods.

Roughly speaking, we may divide Greek vases into four great classes, as follows:—

A.—*Vases of the Primitive Period*, down to about 600 B.C.; decoration in brown or black on a ground varying from white to pale red, often unglazed; human figures and mythological scenes rare.

B.—*Black-figured Vases*, from 600 to 500 B.C.; figures painted in black, like silhouettes, on glazed ground varying from cream colour to bright orange-red, with background of lustrous black varnish; mostly mythological scenes.

C.—*Red-figured Vases*, from 520 to 350 B.C.; figures outlined on red clay, and background filled in round them with black varnish; inner details painted in afterwards; scenes from daily life or mythological. With these are included vases with figures in polychrome on white ground.

D.—*Vases of the Decadence*, from 350 to 200 B.C.; method of class C, but careless and inferior; scenes sepulchral or fanciful; general striving after effect. With these are included various forms of moulded vases or with decoration in relief.

This classification, though serviceable, is of course far from exhaustive, but will form a convenient division for the four succeeding articles which will be necessary to complete the subject. It must, however, be borne in mind that the transition from one to the other is by no means clearly marked, and any such distinctions as these must perforce be more or less conventional.

(To be continued.)

WHAT IS A NEBULA?

By E. WALTER MAUNDER, F.R.A.S.

IN my previous paper* it was my wish to lay stress on the thought that our solar system must not be taken as the type of all systems; that the simplicity of its construction—practically the entire mass of the system being locked up in one central body—must not be supposed to represent, certainly does not represent, the condition of things in other regions of space. To my own mind, indeed, it seems the more probable that such centralized systems are the exception rather than the rule. Possibly the isolation of the solar system has had much to do with this marked autocracy of the sun; if so, we might expect a greater amount of decentralization where two or more systems are in closer neighbourhood to each other.

I wish on the present occasion to suggest that, just as we must not take the mode in which matter is distributed in our system as a type of its distribution in other systems, so neither must we take its distribution in our sun as a type of its distribution in other suns.

In our own sun, as I have before had occasion to point out in KNOWLEDGE,† by far the greatest portion of the sun's mass lies below the photosphere. From the point of view of mass, the chromosphere prominences and coronæ may be neglected. They are probably less important relatively to the sun than our atmosphere is to the earth.

What is even more germane to our present point, they are practically negligeable as to the amount of light which they emit. In spite of the fact that the corona has been traced to a distance of six solar diameters from the sun, as by Newcomb in 1878, and that prominences of a total elevation of three hundred thousand or four hundred thousand miles have been recorded, it still remains the fact that the corona can only be seen when the sun itself is hidden, and the prominences only by the artifice of the spectroscope. Were the sun removed to stellar distances we should have no hint of their presence.

But though these appendages are not sufficiently important in the case of the sun to reveal themselves from stellar distances, we are not without some direct indications of similar formations in the case of some stars. As to prominences, the continual increase in the number of stars showing not only the lines of hydrogen bright, but the helium lines as well, the recent discovery of a bright C line in some well-known stars, and the confidence with which we look for these lines in the spectrum of any *Nova* which flashes out upon our view, point unmistakably to vastly developed prominences and chromospheres as inseparable appendages of a large proportion of stars; whilst Campbell's remarkable observation of a positive hydrogen disc to the star D M + 30°, No. 3659 (*Astron. and Astroph.*, XII., p. 913), stands out as an example more striking in its character than we could have possibly expected.

The indications of stellar coronæ are much slighter. We could not expect it to be otherwise, since as yet we have secured no clear and indisputable record of the corona of our own sun, except during a total eclipse. And the evidently composite character of the coronal spectrum renders it all but hopeless that the spectroscope should assist us here. In effect, the coronal light is chiefly reflected sunlight and white light from incandescent dust particles. Neither of these sources could give us any sign by which to recognize them in the surroundings of a star.

The only available means of detecting a corona is in its faint bright-line spectrum. This consists mainly of the hydrogen and helium lines, and the so-called "coronal" line—1474 on Kirchhoff's scale. But even here it is a moot point whether we should not rather consider these bright lines as properly belonging to the chromospheric and prominence region than to the corona itself. At best, then, our one chance of any hint of a stellar corona is the occurrence of the bright coronal line—1474 K.

It seems to be sufficient, then—it is the utmost the probabilities of the case would lead us to expect—that on two occasions *Novæ* should have shown the 1474 K. line: Nova Cygni in 1876, as observed by Cornu, Vogel, and Backhouse, and Nova Aurigæ in 1892.

These hints as to the existence of stellar chromospheres and coronæ do more than warrant us in concluding that the stars in general possess a structure which in these features resembles that of the sun. They prove—what, indeed, I claim that we ought on *à priori* grounds to expect—that in some instances the stellar chromospheres and coronæ are of vastly greater relative importance than in the sun. The scheme of the general structure is probably alike in all, whilst the proportion which the different details bear to one another varies indefinitely.

These considerations seem to me to have a distinct bearing on the problem of the gaseous nebulæ. It is hard enough to understand how we can have gaseous masses of such enormous extent. The difficulty is increased when we bear in mind how extreme must be their average tenuity. It will be remembered that Mr. Ranyard showed that in the case of the Orion nebula, evidently one of the densest, there was good cause to think that its mean density could not exceed one ten-thousand-millionth of that of our atmosphere at sea-level. To this we have to add the yet further difficulty that the

* KNOWLEDGE for November, 1895.

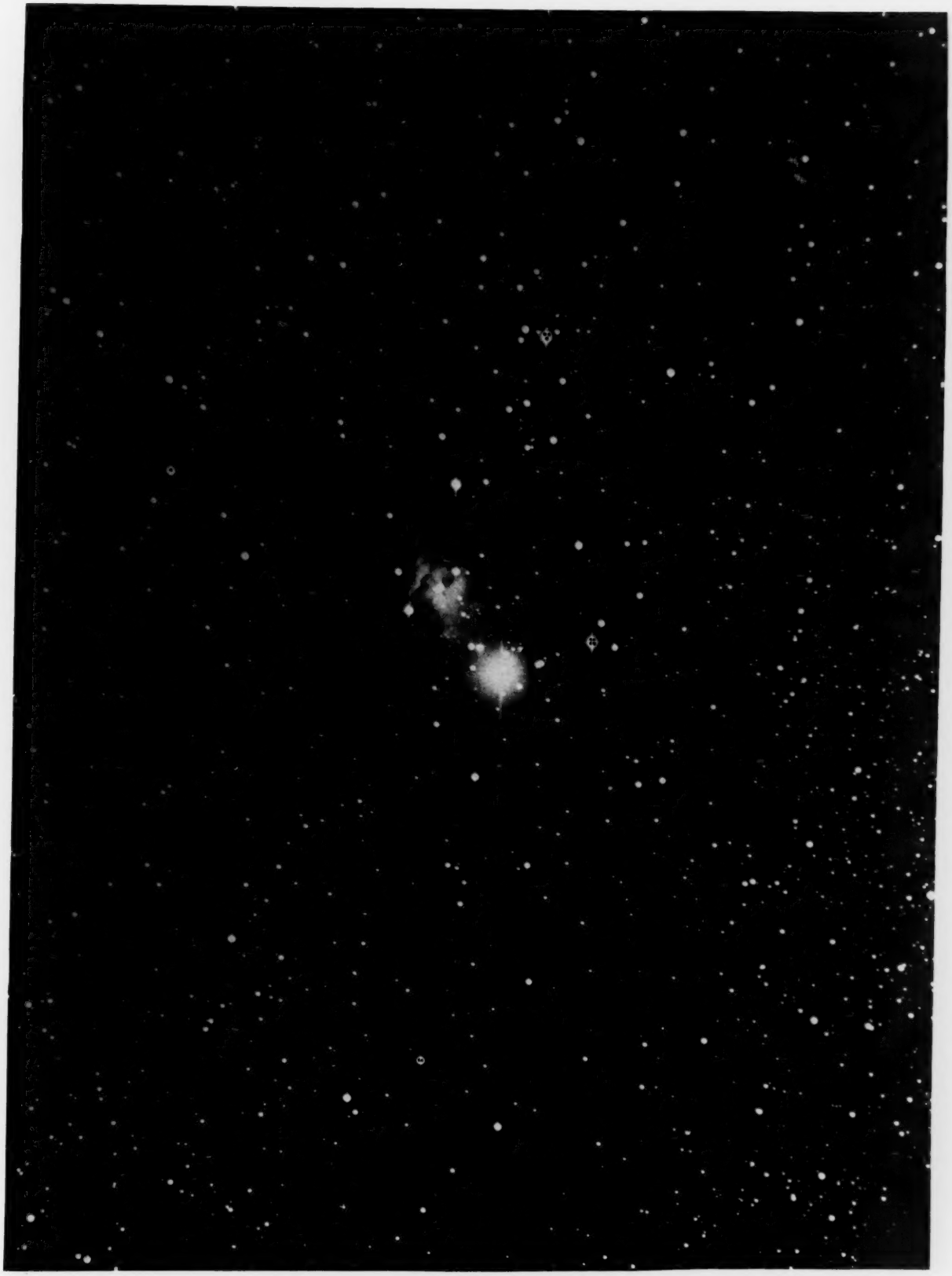
† "The Tenuity of the Sun's Surroundings," March, 1894.

PHOTOGRAPH OF THE NEBULA NEAR 15 MONOCEROTIS.

By ISAAC ROBERTS, D.Sc., F.R.S.

SOUTH.

WEST.



EAST.

NORTH.

XUM

XUM

nebula has no slight luminosity, and the extension of its spectrum far into the ultra-violet points to a considerable elevation of temperature. Yet, on the other hand, the presence of the yellow line of helium would indicate that, in those regions which give this line, the gas is at a far higher pressure than that just indicated. Lastly (and perhaps the most difficult feature of all), whilst we should expect a freely expanding gas to diffuse itself equally and indefinitely in all directions, we find nebulæ taking strange and complicate shapes, and showing here and there strongly-marked outlines.

If we think of nebulæ as merely vast extensions of rarefied gas, it is exceedingly difficult to understand this last-named peculiarity. To take the Orion nebula, for example: how can we explain the sharpness which some of its brightest edges show—the Fish's Mouth, the Great Proboscis; how regard its delicate complexity of detail, if we think of it as merely a vast mass of feebly glowing gas? Look for a moment at Dr. Roberts's striking photograph of Messier 78 in the November number of KNOWLEDGE. Can it be supposed that this is a purely gaseous object, with so well-defined and yet so irregular a margin as that on the *n.p.* side? Or that the curious conical dark area shown in Dr. Roberts's present plate of the nebula near 15 Monocerotis is formed by the retreat from it, through some unexplained force, of the glowing gases which are in such evidence surrounding it? But if we follow out the idea already suggested, that there are in sidereal space systems wherein the arrangement of matter differs from that in the solar system in two directions—first, instead of being concentrated into one sun it is distributed amongst many; and, next, instead of the chief bulk of each of these suns lying below the photosphere, a disproportionate amount exists in the form of chromosphere and corona—it is easy to see that an appearance might be created not different from that which we recognize in many nebulæ.

The aspect of such a system, as viewed from our standpoint, would vary according to the arrangement of the stars, and the relative importance of the actual stars themselves and of their appendages. The closer the stars were together the greater would be the tendency for the hydrogen and coronal streamers to be drawn out to an enormously exaggerated extent, and these might, in the mass, be more apparent to us than the stars themselves; whilst the character of the spectrum of such a group, whether continuous or gaseous, would depend on the relative brightness and surface of the stellar photospheres and of their prominences. In other words, whether it appeared to us as a star-cluster or a nebula would depend largely upon whether its substance was aggregated into comparatively few bodies or distributed over a vast number of inferior size.

If we imagined such a transformation to take place in our own system, the sun being degraded to the rank of a self-luminous Jupiter and the various planets raised to the rank of miniature suns, all with extended chromospheres and coronæ, and we were to view the whole from a great distance, it would appear to us as a spiral nebula; irregular and broken, it may be, but still approximating to the spiral form.

The example of Saturn's rings, where we have a vast number of small bodies so evenly distributed as to appear like a series of solid concentric rings, and the usual diagrams of the solar system, may suggest that a similar target-like appearance would result. But this would not be the case unless the subdivision were carried to the same extreme extent as in the Saturnian annuli. However complicated the orbits of the various little suns might be, each body would only occupy one part of its orbit at any given time, and there would be no other bodies, except by accident, to mark out the rest of its course. At any given time the distribution of these sunlets would be unsymmetrical; but the general tendency, however irregular and broken their arrangement, would usually be towards the spiral form.

Such an object as the great spiral nebula in Canes Venatici need not, therefore, be looked upon as rotating gases, subject to no control but that of the general mass. It is difficult, indeed, to see how it could be conceived as such. But the gases which make their presence evident in it are probably under the control of a great number of somewhat small suns, which form the bright knots that trace out its remarkable spirals. They form, in effect, the chromospheres of these little orbs.

We are not to suppose that these are true stellar atmospheres. As I pointed out in the case of the sun,* the molecules of hydrogen and helium in the prominence region round the sun are probably moving in free paths, and do not build up an atmosphere in which one layer presses on the layer below it. In nebulæ of the kind referred to, but giving a continuous spectrum, we probably have cases where the chromospheric element is less important than the coronal. It is noteworthy—it is a point on which Mr. Ranyard insisted again and again—that the nearest approach to the coronal forms is to be found in the study of nebular structure.

One great objection to the foregoing suggestions lies in the peculiarity of the nebular spectrum. If the sun showed the two lines at wave-lengths 5007 and 4959 the difficulty would be solved. But though the sun fails to give us these two typical lines, yet the balance of evidence appears to show that these are just the lines which *Novæ* give to us in their second or fainter aspect. At their first outburst we get a spectrum which is practically chromospheric; later, when they have faded down, a spectrum which is practically nebular. It may well be that, could we examine the spectrum of the outermost regions of the corona under favourable conditions, we might find these two enigmatical lines; but in the meantime Nova Cygni and Nova Aurigæ are sufficient to form a connecting link between bodies at such opposite ends of the series as our densely concentrated sun and the indefinitely diffused nebulæ.

To sum up, I would wish to urge that our best and safest way to understand the nature of the sidereal structures is to argue from the one system which is sufficiently near us to reveal something of its character—that is to say, our own. But that, whilst we may reasonably take its constitution as a type, just as the structure of one vertebrate may be taken as typical of all, we must be prepared to find the largest differences in the scale upon which other systems are built, and in the proportions which their several parts bear to each other. And a system in which the total mass was distributed amongst very many small members, and in which the chromospheric and coronal element was in large excess of the truly stellar, would undoubtedly appear to us as a nebula. Whether there are nebulæ of an altogether different type is a question beyond my present purpose.

NEBULA NEAR 15 MONOCEROTIS.

By ISAAC ROBERTS, D.Sc., F.R.S.

R.A. 6h. 35m., Decl. N. 10° 0′.

THE photograph covers the region between R.A. 6h. 32m. 56·8s. and R.A. 6h. 37m. 53·8s.; Decl., between 9° 9·6′ and 10° 45·3′ North.

Scale, 1 millimètre to twenty-four seconds of arc.

Co-ordinates of the Fiducial stars marked with dots for the epoch A.D. 1900.

* KNOWLEDGE, March, 1894.

Star (·). D.M. No. 1322. Zone + 9°. R.A., 6h. 33m. 42·0s. Decl., N. 9° 44·5′. Mag., 8·1.
Star (··). D.M. No. 1215. Zone + 10°. R.A., 6h. 35m. 3·8s. Decl., N. 10° 28·9′. Mag., 8·8.
Star (·.·). D.M. No. 1344. Zone + 9°. R.A., 6h. 35m. 40·5s. Decl., N. 9° 34·0′. Mag., 8·1.
Star (::). D.M. No. 1350. Zone + 9°. R.A., 6h. 35m. 57·4s. Decl., N. 9° 56·7′. Mag., 8·3.

The photograph was taken with the 20-inch reflector on February 13th, 1895, between sidereal time 4h. 20m. and 7h. 23m., with an exposure of the plate during three hours.

REFERENCES.

N. G. C., No. 2264; G. C., No. 1440; h 401; Lord Rosse, *Obs. of Neb. and Cl. of Stars*, p. 53; Prof. Barnard, *Astronomy and Astro-physics*, Vol. XIII., pp. 178, 182.

Sir J. Herschel and Lord Rosse suspected 15 *Monocerotis* to be a nebulous star, or else involved in nebulosity; but they could not detect any nebulosity in the region surrounding the star.

Prof. Barnard took three photographs of the region in January and February, 1894, and upon them found nebulosity covering a diameter of about three degrees; but the photo-instrument which he used had only an aperture of six inches and focal distance of thirty-one inches. The scale of the photographs is, therefore, too small for showing the structural details of the nebulosity, which are partly shown on the print herewith presented, and more clearly visible on the original negative.

The star (15 *Monocerotis*) is involved in the centre of the light-circle at the centre of the print; and the rays of light which are seen in the north, south, east, and west directions, from the star, are not objective, but due to instrumental causes.

COMETS OF SHORT PERIOD.

By W. E. PLUMMER, M.A., F.R.A.S., *Director of Bidston Observatory.*

WITHIN the last few years some of the comets of short period have shown a tendency to behave in an irregular and unexpected manner. They no longer present the well-regulated class of objects that they did in, say, the middle of the century, when, less numerous, their return could be counted upon with confidence, and their appearance predicted with an approach to certainty. While some have probably disappeared as distinct comets, fresh discoveries have added others—sometimes, indeed, suggesting reappearances of old friends—till the very nomenclature has become confusing; so that it seems desirable to review the entire history, and endeavour to straighten out some of the difficulties that the addition of fresh members to the solar system has introduced. Evidently and conveniently, the entire family of periodic comets, or rather of those whose aphelia fall near the orbit of Jupiter, can be divided into two classes: those which have been observed at more than one apparition, and those which have only been seen once. The first list can be again subdivided with advantage, since it contains specimens of two very different classes, namely, those which remain with us after one or more revolutions, and those which, after pursuing a regular course, have subsequently been lost. The following table contains those, and those only, whose reappearance can be counted upon with tolerable certainty. The order of arrangement is that of the respective mean distances from the sun.

Ordinary Designation of Comet.	Period in Years.	Date of last Perihelion Passage.	Approximate date of next Return.	Aphelion Distance in terms of Earth's Distance.
Encke ...	3·303	1895, Feb. 4	1898, May 26	4·095
Tempel ...	5·211	1894, April 23	1899, July 10	4·665
Tempel-Swift	5·534	1891, Nov. 14	1897, May 28	5·171
Winnecke ...	5·818	1892, June 30	1898, April 25	5·583
Finlay ...	6·627	1893, July 12	1900, Feb. 26	6·064
D'Arrest ...	6·691	1890, Sept. 17	1897, May 27	5·778
Wolf ...	6·821	1891, Sept. 3	1898, June 30	5·601
Faye ...	7·566	1896, Mar. 19	... ...	5·970

The first fact that strikes one on glancing through the table as a whole, and before entering into any details, is the small number of regularly returning comets that have remained permanent members of our system. The facility with which comets can be lost will be further accentuated when we enter upon the second list, and show the comparatively large number that have been added by recent discoveries and whose return is still doubtful. These recent additions to our catalogues within the last few years seem to suggest that the proportion of elliptical to parabolic comets has greatly increased. This can, in some measure, be attributed, possibly, to the discovery of fainter objects, due to the employment of larger telescopes in "sweeping." Not that this explanation is altogether satisfactory, because it ought to follow that the total number of cometary discoveries of all kinds is strikingly greater than was the case thirty or forty years ago, and this is not borne out by the facts. Another point, not without its interest, is that the increase in the aphelion distance has not kept pace with the increase in the period. From Encke to Faye, this increase in period implies by Kepler's law an increase of the mean distance from 2·218 to 3·854, expressed (here as in all other places where distances have to be mentioned) in terms of the earth's mean distance from the sun. The aphelion distances, however, do not exhibit the same tendency to spread. The controlling influence of Jupiter is here suggested.

It will not be necessary to consider all the comets in the list in detail. For instance, the history of Encke's comet has been many times written, and it is quite unnecessary to refer to the numerous interesting points connected with its motion. It is true that the last chapters, and not the least interesting, in its history have not been given with complete fulness in some recent text-books; and the care that has been bestowed on the difficult problem of separating the effects due to a so-called "resisting medium" from others arising from the use of an erroneous or questionable value of the mass of Mercury, has not yet met with a sufficient notice in popular works.

It is otherwise with the comet described as Tempel—or Tempel 1873—because the comet is very liable to be confounded with another of short period which the same astronomer first saw six years earlier in 1867. The first return of this last-mentioned comet occurred in 1873, and, consequently, in that year *two* periodic comets, both credited to Tempel, were under observation. This comet of 1867 has now probably disappeared, and it will be referred to again under the head of the more doubtful visitants. Number two in our list was seen in 1873 and again in 1878. In 1883, and in 1889, when, according to its period, it must have returned to the sun, the chances favourable for observation were very slight, and it passed through perihelion without being seen. In 1894, however, Mr. Finlay, of the Cape Observatory, was fortunate enough to find it, and so carefully had the calculations been made by M. Schulhof, that, notwithstanding the long interval

that had elapsed since 1878, the predicted place was very close to the actual. This happy recovery makes one hesitate before pronouncing a comet lost, and necessitates a close examination of the circumstances under which the return takes place.

The third comet on the list is not likely to cause any confusion, because a second name is attached to that of Tempel, who first found the comet in 1869. This addition of Swift's name marks a particular fact in its history, which serves to identify the comet. No definite orbit was derived from the observations of 1869, although it was known that parabolic elements would not represent the path. Consequently, no indication of its future career was made. The comet made its approach to the sun in 1875 and was not seen, but in 1880 it was independently discovered by Prof. Swift, whose name is therefore linked in the description. One peculiarity in its history arises from the fact that its period is almost exactly five and a half years, so that for a long time the returns will be alternately favourable and unfavourable for observation. In 1886 it passed unnoticed; but in 1891, when its theoretical brilliancy was one hundred times greater, it was well observed, and is apparently as much a permanent member of our system as a comet can be.

Winnecke, D'Arrest, and Faye call for little remark. They have been under regular observation for approximately half a century, and are well under control. Winnecke dates back to 1819 with certainty, and probably to 1766, though it was not till 1858 that its peculiar motion was recognized. D'Arrest was first observed in 1851, and has been repeatedly seen since, though the circumstances of its return are occasionally unfavourable. Faye, a comet which is now under observation in our larger telescopes, has run an uniform course since 1843, and has, thanks to Prof. Axel. Möller's admirable discussion, perhaps proved itself the best timekeeper of the periodic comets.

The two remaining comets, those of Finlay and Wolf, are modern introductions, and are entitled to more consideration on account of the many interesting problems they offer for solution in regard to the capture of comets by Jupiter, or the connection that may exist with older comets since disappeared. In the case of Finlay, the position of the orbit with reference to the ecliptic is very similar to that of the comet 1844 I. (known as De Vico's), a comet which will appear in the second list, for though undoubtedly periodic it has never been seen since that date. The dimensions of the orbit do not accord so well, but the disagreement is not so great but that the plausible hypothesis was raised at the time that the 1844 comet had encountered a small planet and suffered considerable perturbation. But Finlay's comet requires more than a year longer for its revolution about the sun than does De Vico's, a circumstance which evidently tells against the probability of the two objects being identical, since it is difficult to understand how one element of the orbit should be so materially affected and the others remain comparatively undisturbed. If two objects, seen to be moving in similar orbits after a considerable interval, are concluded to be identical because of this similarity, it must be assumed that perturbation in the interval has been slight, and therefore cannot be invoked to explain one point of difference. Another supposition which has been raised is that the comet is a reappearance of that known by the name of Lexell—seen once, and once only, in 1770. This point can be more conveniently considered in treating of the second catalogue, since another comet known as Brooks', 1889 V., also has claims to be considered the lost Lexell. Fortunately, Finlay's comet was seen in 1892 (though somewhat fainter than could have been wished), and its past history can therefore be well determined; but it will remain in our catalogues distinguished by the name of the discoverer. There is another and a much larger question. Is the present condition of cometary astronomy insufficient to decide with certainty the identity of two comets? That is to say, is it possible for astronomers to accumulate observations of the same body and believe them to refer to two distinct objects? That is a question which it is hardly safe to answer categorically, but it is one to which we shall return.

Wolf's comet, the last on the list, has a history as interesting as any. It was first seen in 1884, and the earliest published elements showed similarity with those of a comet discovered by Coggia in 1874, and whose probable period is three hundred years. More trustworthy elliptic elements proved, as Dr. Hind pointed out, that the path of the comet approached very closely to that of Jupiter, and that in May, 1875, the comet was actually so near to that planet as to be brought within its influence. This point has been examined very closely by the lately deceased M. Lehmann Filhés; and he has derived, with very close approximation, not only the elements in which the comet moved when under the influence of Jupiter's attraction, but also the character of the orbit before undergoing that violent alteration. This inquiry explains why the comet had not been previously seen, though it may have regularly revolved about the sun for ages before. The original elements, as we may call them—that is, previous to 1875—possessed a much smaller eccentricity with a longer period. Consequently the perihelion distance had been materially reduced by Jupiter's attraction (as a matter of fact to about one half that which it previously had), and the practical effect for us was to bring the comet within the range of our telescopes. The investigation will probably be made again more rigorously, and with more correct data; but, as it stands, it offers a very satisfactory explanation of the reason why the comet had not been seen earlier, and was seen then. It must have passed us in 1878, but it is known that the position in the sky was then unfavourable.

We have now to consider three comets, all of which there is grave reason to believe have escaped beyond our cognizance, and are no longer to be recognized as comets. They are given in the following table in the order of their period, together with some additional information which may assist us in forming an opinion of their possible recovery:—

Ordinary Designation of Comet.	Period in Years.	Date of last observed Return.	Number of Returns observed.
Brorsen	5·456	1879, March 30th	Five
Tempel	6·507	1879, May 6th	Three.
Biela Nucleus I. ...	6·587	1852, Sept. 23rd	Six.
Biela Nucleus II....	6·629		

It is, perhaps, a little premature to consider the first—Brorsen's—hopelessly lost, though the table shows that it has not been seen since 1879, to which must be added the significant fact that though the comet passed through its perihelion this autumn, no serious effort appears to have been made to recover it. In some respects the history of the comet resembles that of Wolf, last mentioned, inasmuch as it was brought within our range by the disturbing action of Jupiter a few years before it was discovered. In 1846, Brorsen first observed it, and in 1842 the comet made a close approach to that planet, with the result that the perihelion distance was much reduced, being brought down from 1·5 to 0·6, an alteration of the same character as was instanced in the case of Wolf, and one which, of

course, made the comet brighter, since it brought it closer to us. But there is another point about the orbit of not less interest: the motion is of such a character that every ninety-five years it must come under the influence of Jupiter; but the action of that planet will not always be favourable to its continuance with us, and in 1937, had the comet pursued the even tenour of its way, it might have been deflected into a hyperbolic path. It would have been highly gratifying had the comet remained visible till we could have accounted for its disappearance as satisfactorily as for its introduction. And this may happen yet, for the comet has shown fluctuating values in brilliancy and may recover. If we consider a comet to shine by reflected light it is evident that its brilliancy should vary inversely as the product of the squares of its distance from us and from the sun. On this supposition we can compute its theoretical brilliancy for the first and last time at which it has been seen at each apparition. Of course the quantities are not strictly comparable. Proximity to the sun, or the presence of moonlight, may rob us of the comet where under better conditions it would have been visible in our telescopes. The values of this brilliancy are set out in the following table, and the apparently hopeless expectation of seeing it again is emphasized by the fact that in 1890 the brilliancy exceeded 8·0, and though sought by many experienced observers the comet remained invisible.

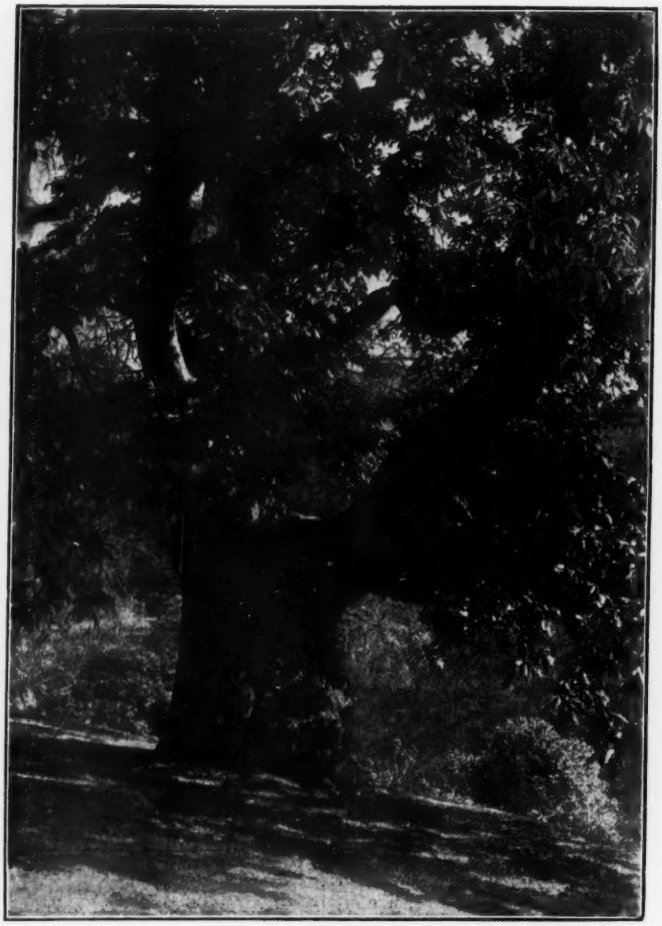


Fig. 1.—Spanish Chestnut Tree.

Date.	Brilliancy when first seen.	Brilliancy when last seen.
1846	5·42	0·46
1857	1·67	0·34
1868	1·65	0·16
1873	1·10	1·68
1879	0·12	1·46

In taking into consideration the causes that may prevent the due return of a comet, we must not leave out the chance of a collision with a small planet, when the comet might be scattered, or more probably deflected into a new path and therefore become unrecognizable to us. The chances of such a catastrophe would depend very much upon the angle that the comet's path made with the ecliptic. The smaller this angle, evidently the greater the chance of encountering an asteroid; and usually this angle, known as the inclination of the orbit, is small in the case of the comets we are considering. The inclination of the orbit of Brorsen is, however, very considerable—greater than that of any of the short period comets. Nevertheless, the orbit is so situated that it can approach certainly three of these small objects, namely: Hebe, within 0·073; Hesperia, within 0·043; and Artemis, from which it may be distant one-tenth. Such distances, when turned into miles by multiplying them by the earth's distance from the sun (more than 92,000,000 miles), seem to offer ample space for a comet to pass unmolested; but taking into account the probable large number of small planets yet undiscovered, it is impossible to deny the chances of unexplained perturbation.

The second comet on the list is the one referred to in connection with that of Tempel 1873. This may now be regarded as lost, seeing that it has been unsuccessfully looked for at several returns, and the mean motion must now be very uncertain. Jupiter, whose influence has on several occasions, as we have seen, been exercised to increase the number of our comets, has, in this instance, operated to remove one. Remembering that Jupiter's period is 11·86 years, and that this comet had in 1879 a period of 5·98 years, it is evident that at each alternate revolution the comet and Jupiter must occupy, approximately, the same relative positions. In 1870 the comet was only 0·32 distant from the planet, consequently in 1881 there was another close approach. The perturbations on these two occasions were excessive, and the elements of the orbit of 1885 differ very materially from those in 1867. If we consider only the period, the most important for our purpose, we have—

1869 ... Period, 5·694 years ... Approaches Jupiter within 0·32.
1873 ... „ 5·964 „ ... No approach.
1879 ... „ 5·981 „ ... Approaches Jupiter within 0·55.
1885 ... „ 6·510 „ ... No approach.

This increase in the period, or in the semi-axis major, is accompanied by a corresponding increase in the perihelion distance, so that the comet can never be closer to the sun than twice the earth's mean distance—that is to say, con-

siderably outside the orbit of Mars. Such a removal from the sun has, of course, robbed the comet of much of its brilliancy—never very great; and this, accompanied with the uncertainty in its actual position, explains the reason of its invisibility, and makes us despair of seeing it again.

Concerning Biela, like Encke, it is unnecessary to say anything. It has a history so interesting and special that it is everywhere known. Of its division into two parts, of its subsequent disappearance and re-observation as a shower of meteors, it is unnecessary to speak, as these facts are impressed on the memory of all.

THE SPANISH CHESTNUT.

By George Paxton.

"Than a tree a grander child earth bears not."

TAKING the word in its widest meaning, what is more useful to man than a tree? or what more ornamental to old mother Earth? A country without trees we cannot imagine to be anything but a desert. Yet our commoner trees are very imperfectly known. A few short papers, treating them in a popular manner, avoiding all botanical names and technical terms whenever possible, will, we think, prove interesting, as well as instructive, to our readers.

If a "tree is known by its fruit," the *chestnut* ought to be one of our best known trees. Few there are unacquainted with the chestnut barrow of the London streets and its hot contents, or who have not burned their fingers roasting chestnuts at the hearth on a cold winter's evening. We purpose, therefore, to confine our remarks in this number to a few facts about the sweet chestnut.

Fig. 2.—Leaves and Fruit of Spanish Chestnut. (About one-fourth natural size.)

This tree is commonly called the Spanish chestnut, to distinguish it from the horse chestnut; botanists call it *Castanæ vesca*. It is very well known and largely grown in this country, coming next to the oak in point of size and the durability of its timber. Some authors consider it indigenous to Britain, but it appears more probable that, notwithstanding the great age of some of our chestnuts, this is not the case. However, it has a very wide distribution, being found in Europe, Asia, North Africa, North America, and all the sub-tropical islands of the Atlantic.

The tree grows to a height of from sixty to one hundred feet, and sometimes attains an immense girth; the leaves are large, oblong, shining, and serrated (Fig. 2), of a beautiful light green colour. Foliation takes place about the middle of May, and the leaves are retained till late in the autumn, sometimes till midwinter. The fruit, unfortunately, does not come to perfection in large quantities in this country, most of the chestnuts we consume being foreign. In France, Spain, and Italy these nuts form an important article of food, where they serve in a great measure as a substitute for bread and potatoes. From these countries we import annually upwards of fifty thousand bushels of chestnuts.

The wood of this tree, when it is cut comparatively young, is excellent for building purposes, and also for furniture, its close grain enabling it to take a good polish. It is also largely used for making wine casks; the wine is said to ferment more slowly in them than in casks made of any other wood.

The most celebrated chestnuts in the world are those growing on the slopes of Mount Etna; the largest, which is said to be over two thousand years old, is called "*Castano di Cento Cavalli*"—the chestnut of a hundred horses. Its girth was over two hundred feet a hundred years ago. The trunk is hollow, and a family reside in it; while a whole flock of sheep is likewise folded in the enclosure! Another tree on the same mountain is seventy feet in girth, and a third sixty-four feet the stems of these trees attain no great height, but branch off near the ground, and their great girths are probably the result of rooting of many of the branches, thus forming immense bushes rather than single trees. The famous Torthworth Court chestnut is the largest tree in England (if still standing), its girth being fifty-two feet. The largest tree in Scotland for many years was the Finhaven chestnut in Forfarshire; its girth was forty-two feet eight-and-a-half inches, but it was cut down about twenty-five years ago.

In the beautiful landscapes of Salvator Rosa this is the favourite tree. In the mountains of Calabria, where Salvator lived, the chestnut flourished; there he studied it in all its forms, breaking and disposing it into beautiful shapes as his composition required.

XUM

Virgil mentions the chestnut in his "Eclogues" and in his "Georgics" as a tree. In the first Eclogue he says of its fruit:—

"Ripe apples and soft chestnuts we have there,
And curd abundant to supply our fare."

And in his second Eclogue, as rendered by Dryden, he writes:—

"Myself will search our planted grounds at home
For downy peaches and the glossy plum,
And thrash the chestnuts in the neighbouring grove,
Such as my Amaryllis used to love."

The old English poets frequently allude to the chestnut, and Milton refers to the custom of roasting chestnuts when he says:—

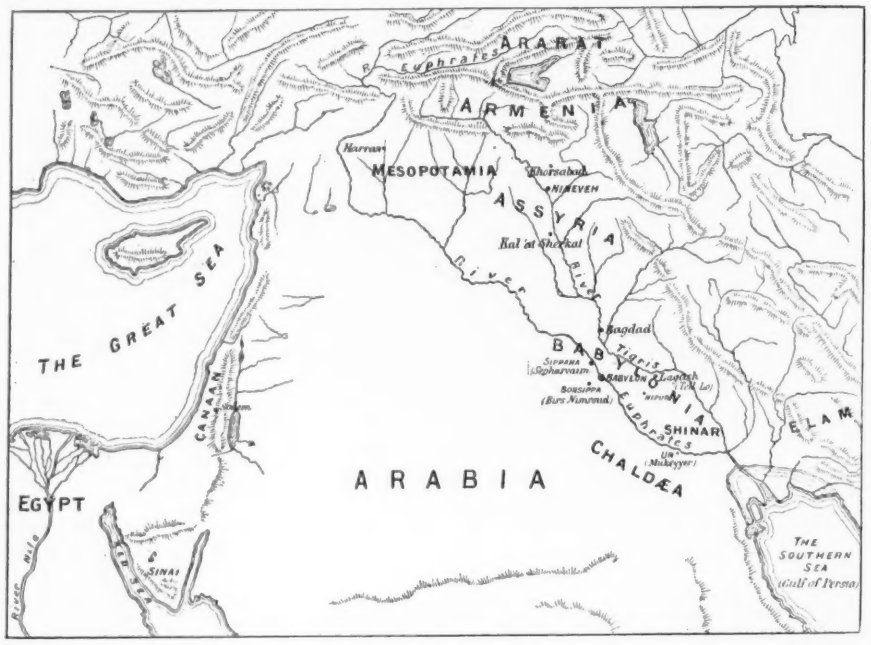
"While hisses on my hearth the pulpy pear,
The black'ning chestnuts start and crackle there."

LIFE IN BABYLONIA IN PATRIARCHAL TIMES.

By THEO. G. PINCHES, M.R.A.S.,

Department of Egyptian and Assyrian Antiquities, British Museum.

ACCORDING to Babylonian chronology, the patriarchal age in Palestine seems to have corresponded with the period immediately following 2200 B.C., the earlier portion probably differing from the received chronology by two or three hundred years. This question of chronology is a difficult one, and, though important, does not really belong to the scope of the present paper. Those who wish to go into the question of dates may consult the works of Sayce, Oppert, Schrader, etc., though, to say the truth, a really satisfactory scheme of chronology must, in the present imperfect state of our knowledge, necessarily be a matter of time. Those who read the present paper to the end, however, will see why the date of 2200 B.C. has been chosen as the earlier limit of the period treated of.



Sketch Map of Western Asia.

The age of the patriarchs in Palestine appears, from the account that has come down to us, to have been one of great simplicity of manners and customs, and of an exceedingly primitive state of civilization. All civilization was then (compared with the present day) exceedingly primitive and simple, but it must not be imagined that the standard of the Hebrew patriarchs is to be that for the civilized world at that age. As early as 3800 B.C. the cuneiform writing in use in Babylonia had not only lost, for the most part, the hieroglyphic form which it originally had, but had also become highly artificial; and certain arts, notably that of engraving on hard stone, had made considerable advances. For sixteen hundred years after that time civilization had been marching with slow and measured pace (for everything goes slowly in the East), struggling in the trammels of superstition, and against the retarding incursions of barbarous hordes—disadvantages with which it had to contend until the world was well within the present enlightened era.

Whether, when Abram, the father of many of the Semitic tribes, was in the district or city known as Ur of the Chaldees, he was living in a town or in the country is uncertain. The general opinion among scholars at present is that Ur is to be identified with the ancient city of Uri or Uriwa, now represented by the mounds known as Mugheir (Mukeyyer), in Southern Babylonia. This may be so; but it seems to be more likely that Ur of the Chaldees (Ur-Kasdim) is simply the Akkadian name of the district (not the city) known as Akkad, which, in the language there spoken, was called Uri. Abram, with his flocks and herds, would probably have preferred to live out in the country, rather than in (or even so near as to be called "in") a city. The cities of Babylonia, however, must have been well known to him during the time that he lived there. Small reason would an inhabitant of the plains have to love the cities of Babylonia—just as little as he would love the cities of the East to-day. The streets were narrow and the houses small. The walls were mostly of unbaked brick, sometimes plastered over, and the fireplaces were primitive in the extreme. The drainage, it is needless to say, was unsanitary. The builders of the houses knew, nevertheless, the importance of keeping the walls free from humidity, for they constructed drains and ventilators in them for that purpose. Life in an old Babylonian town, even with all the comforts of a royal palace of

the time, would have fallen far short of what we are accustomed to in most of the houses of Europe to-day. Life outside, in a tent, would certainly have been preferable. To a monotheist, also, the heathen practices of the polytheistic Babylonians must have been far from sympathetic, however much he might have admired their intelligence, their philosophy, their civilization, their love of justice, and their kind-heartedness, which was, to all appearance, often thoroughly disinterested.

In judging the character of the people of that time, with their manners and customs, and their morals, so different from ours, we are bound to take in consideration the influence of their surroundings. For them and their contemporaries there was nothing wrong in polygamy and the possession of concubines, and slaves were chattels to do as one liked with; and it is in consideration of these customs that we must look upon the possession of two wives, as the following, from a tablet in the British Museum, shows:—

TABLET RECORDING THE MARRIAGE OF TWO SISTERS TO ONE HUSBAND.

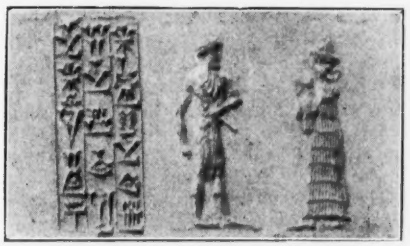
"Arad-Samas, son of Ili-ennam, has taken Iltani, sister of Taram-Sagila, from Samas-tatum,* their father, as his wife. Iltani is his consort. He will provide for her, he will care for her, he will carry her seat to the temple of Merodach. The children, as many as have been born, and as they will bear, are their children (*i.e.*, the children of Iltani and her sister). If she (Taram-Sagila) say to Iltani, her sister, 'Thou art not my sister,' then . . . . † [if Iltani] say [to Arad-Samas] 'Thou [art not my husband],' then he may set a mark on her and sell her for silver; and if Arad-Samas say to his wife, 'Thou art not my wife,' then he shall pay her one maneh of silver.‡ And they (two), if they say to Arad-Samas, their husband, 'Thou art not our husband,' then (the people may) strangle (?) them, and throw them into the river."§

The names of the witnesses close the inscription.

Impression of a Cylinder-Seal such as was used in sealing contracts. Deities and worshipper, with the name of the owner of the seal, his father, and the deity he served. About 2000 B.C.

When two sisters were wedded to the same man each had a tablet very similar in wording to the above, but with the position of their names changed. Such a tablet was, in fact, a woman's marriage certificate, and testified to her respectability. In all probability she had but little chance of re-marriage without it, for the reputation of a woman was a most important thing to her in the ancient East.

It is a noteworthy fact that the ancient Babylonians were at all times great lovers of legal forms, for they invested every transaction of life that could be so treated in the robe of the law. Not only the wedding ceremony, but the hire of a slave, a loan, a gift, an exchange, a sale, were all upon the same footing with partnership and its dissolution, adoption, inheritance, etc. Whenever a difficulty arose (and disputes were not infrequent), a judge was taken to pronounce a decision upon the merits of the case. These legal actions often (perhaps generally) took



Impression of a Cylinder such as was used in sealing contracts. Deity and worshipper, with the name of the owner of the seal, his father, and the god he served. About 2000 B.C.

place in the temple of Samas, the Sun-god, this deity being regarded as the great "decider of decisions" and "the judge of the world," the pronouncements of whose judges he was supposed to direct.

The following will give an idea of the circumstance attending a deed of gift:—

"Lamasu, their mother, has given to Sili-Samas one slave (named) Ana-Samas-kalama and 10 shekels of silver; 10 shekels of silver, and 10 shekels of silver (as) the wedding-gift (of the wife that he has taken), to Sin-mubalit, his brother; and 15 shekels of silver to Taribu, his brother. Never shall Sili-Samas, Sin-mubalit, his brother, and Taribu, his brother, have any claim upon what Lamasu, her son Apil-îli, her son Amat-Rammani, and Mâd-Rammani, her daughter, have and will possess. She has written (this) with their consent. At no time shall they make any claim. They have sworn by Sin, Samas, and Khammurabi the King."

The names of several witnesses (whose seals are impressed) follow, after which comes the date:—

"Month Adar, of the year Khammurabi the King renewed for Istar and Nanâa the temple Ê-tur-kalama."

The sale of a house was couched in similar terms:—

"One *sar* (of land), a house on a platform (?), beside the house of Sili-Nanâa, (and) beside the property of the sons of Ubar-Sin, (one) end the street, and (the other) end the house of Sin-azu. From Minanu son of Migrat-Sin, and Ili-turam his son, Sili-Nanâa son of Ili—*, and Apil-ili his brother, have bought it for 3½ shekels of silver, its complete price. At no future time shall they litigate against each other (concerning the house). They have invoked the name of the King."

Here follow the names of nine witnesses.

"His seal and the seals of the witnesses have been impressed. Month Sebat, day 26th, year of Rim-Sin, when the enemy who was wicked (smote (?) the lands)."

That slavery was in full swing may be gathered from the above texts (see the deed of gift), and sales of slaves similar to the following were therefore very common:—

* Or Samassatum.

† Apparently one or the other was an adopted daughter of Samas-tatum, as, logically, a real relationship, such as that of sister, cannot be changed by the utterance of *any* formula.

‡ This was the act of divorce, the penalty for which, in the case of a man, was a money payment only.

§ See Meissner, "*Beiträge zum alt-babylonischen Privatrecht*." No. 89. He quotes also a tablet (92) in the Berlin Museum which is very remarkable for its form: "Akha-nusa has given Napirtum to a husband; no one shall part her asunder. One shekel of silver is her dowry. He who slanders her has committed sin. No one shall part her asunder."

"Two hundred and four and two-thirds *ka* of oil, property of the Sun-god, value one-third of a mana, and two-thirds of a shekel of silver, as price of the fair (-skinned) slaves of the land of Gutî, Arad-Marduk son of Ibni-Marduk has received, by the authority of Amel-Mirra son of Ili-usati, from Ubala-abi-ûmê. He will bring the fair (-skinned) slaves of Gutî in a month's time. If he do not bring them in a month, then Arad-Mirra shall pay, according to his contract, one-third of a mana and two-thirds of a shekel of silver."*

One might go on, however, indefinitely quoting interesting and important texts referring to this primitive and yet elaborated civilization of those early times. Enough has been given, however, to show what was the nature of the society and the civilization of the time; and it has this great advantage, that it all comes to us at first hand, from the people themselves. The texts are the same now (when they are complete) as on the day when the scribe wrote them, and impressed the cylinder-seals of the witnesses.

There is a noteworthy point in the life of the patriarch Abram that may here be touched upon, and it is a point that must have struck many in former days. Abram, a simple shepherd owning his own flocks, sets out from Ur of the Chaldees, and not only traverses Western Asia, but even visits Egypt; and in all the narrative there is not a word referring to any difficulty that he may have had in making himself understood.†

In Babylonia in ancient times it would seem that many languages or dialects were spoken, and these tongues the tradesman or farmer probably knew from his youth up. One of them, Babylonian (generally called Assyrian), he would speak as his mother-tongue, and of Sumerian and its dialect (Akkadian) he would know at least a smattering. From the Aramaic tribes in the country he would naturally be able to get a knowledge of Aramaic, and from the Amorites who were in Babylonia (there was an Amorite district in or near Sippara, now Abu-habbah, in about 2080 B.C.) he could obtain a knowledge of the language spoken in Southern Palestine and elsewhere—a tongue, in all probability, closely akin to Hebrew. For a journey to Egypt the above would be most likely all that was needed by him to communicate with the natives, for the Egyptian Pharaoh was, it is supposed, of Semitic origin, and he and many of his people must have understood the language of Western Asia. Any further aid that the traveller might require, however, he would find ready to his hand in the language now known as Assyrian (really Babylonian), which, as it was the *lingua franca* of 1500 B.C., must have held the same position in Abram's time; and the traveller could, in all probability, have traversed the whole distance from Babylonia to Egypt (over a thousand miles as the patriarch must have gone), communicating with the inhabitants of the countries he passed through by this means alone. A traveller's linguistic equipment in those days was complete if he possessed some knowledge of Aramaic and Amorite as well.

Recent researches have, indeed, removed not a few hindrances to our perfect knowledge and understanding of the early history of that East which is so full of poetry and romance, and so important for the history of civilization. What may we not find when more of the many buried cities of the East shall have been explored by the excavator? Among the many thousand tablets that still lie buried there, who can say what may not come to light?

* Meissner, *Beiträge*, No. 4.

† Apparently, also, he was never molested by lawless tribes—a condition of security which could not be claimed for this part of the world now.

Science Notes.

Experiments have been made upon the bending of small bars of ice, supported at the ends in a horizontal position and loaded at the middle; and it is found that if such a bar is so cut that the optical axis is perpendicular to the length the load causes considerable bending, but a rod having the optical axis horizontal shows no appreciable bending under these conditions. This agrees with the supposition that ice crystals consist of thin laminæ, formed of a flexible but almost inextensible substance, the interspaces being filled with a separating medium which is sufficiently viscous to retard the mutual gliding of the plates.

We learn that both Messrs. Cook & Son and Messrs. Gaze & Sons are making special arrangements to convey astronomers and others to Vadsö, for the purpose of viewing the eclipse of the sun which is to take place on August 9th next.

THE FACE OF THE SKY FOR FEBRUARY.

By Herbert Sadler, F.R.A.S.

SUNSPOTS and faculæ are evidently decreasing in number. There will be an annular eclipse of the Sun on the **13th**, but it will only be visible in the southern hemisphere. Conveniently observable minima of Algol occur at 9h. 43m. P.M. on the **6th**, at 6h. 32m. P.M. on the **9th**, at 11h. 25m. P.M. on the **26th**, and at 8h. 14m. P.M. on the **29th**.

Mercury is not very favourably situated for observation this month. On the **1st** he sets at 6h. 10m. P.M., or 1h. 24m. after the Sun, with a southern declination of 10° 50′, and an apparent diameter of $8\frac{3}{4}''$, $\frac{2}{10}$ths of the disc being illuminated. He is in inferior conjunction with the Sun on the **8th**. After this he becomes a morning star, but is badly situated for observation owing to his great southern declination. On the **15th** he rises at 6h. 26m. A.M., or 52m. before the Sun, with a southern declination of 14° 13′, and an apparent diameter of 10″, $\frac{12}{100}$ths of the disc being illuminated. On the **20th** he rises at 6h. 7m. A.M., or one hour before the Sun, with a southern declination of 15° 34′, and an apparent diameter of 9″, $\frac{26}{100}$ths of the disc being illuminated. On the **29th** he rises at 5h. 52m. A.M., or one hour before the Sun, with a southern declination of 16° 15′, and an apparent diameter of $7\frac{1}{2}''$, about one half of the disc being illuminated. He is in Capricornus during the month.

Venus is a morning star, but is rapidly fading in brightness, and her southern declination is very great. On the **1st** she rises at 5h. 26m. A.M., or two hours and a quarter before the Sun, with a southern declination of 22° 0′, and an apparent diameter of $14\frac{1}{3}''$, about three-quarters of the disc being illuminated. On the **10th** she rises at 5h. 36m. A.M., or 1h. 50m. before the Sun, with a southern declination of 21° 42′, and an apparent diameter of 14″, $\frac{8}{10}$ths of the disc being illuminated. On the **20th** she rises at 5h. 41m. A.M., or about one and a half hours before the Sun, with a southern declination of 20° 23′, and an apparent diameter of $13\frac{1}{2}''$. On the **27th** she rises at 5h. 38m. A.M., or 1h. 12m. before the Sun, with a southern declination of 18° 21′, and an apparent diameter of 13″, $\frac{83}{100}$ths of the disc being illuminated. During the month she passes from Sagittarius into Capricornus.

Mars, Saturn, and Uranus are, for the observer's purposes, invisible.

Jupiter is a magnificent object in the evening sky, and is admirably placed for observation, being visible all night long. On the **1st** he rises at 3h. 38m. P.M., with a northern declination of 20° 10′, and an apparent equatorial diameter of 46½″. On the **10th** he sets at 6h. 56m. A.M., or half an hour before sunrise, with a northern declination of 20° 26′, and an apparent equatorial diameter of 46″. On the **20th** he sets at 6h. 14m. A.M., or 54m. before sunrise, with a northern declination of 20° 41′, and an apparent equatorial diameter of 45⅓″. On the **29th** he sets at 5h. 36m. A.M., or one hour and a quarter before sunrise, with a northern declination of 20° 5′, and an apparent equatorial diameter of 44½″. He is in Cancer during February. The following phenomena of the satellites occur before midnight on the days named, while the planet is more than 8° above and the Sun 8° below the horizon: On the **1st** a transit ingress of the first satellite at 7h. 17m. P.M., of its shadow at 7h. 30m. P.M.; a transit egress of the satellite at 9h. 38m. P.M., and of its shadow at 9h. 50m. P.M. On the **2nd** an eclipse reappearance of the first satellite at 6h. 55m. 25s. P.M. On the **4th** a transit ingress of the second satellite at 9h. 12m. P.M., and of its shadow at 9h. 47m. P.M. On the **5th** an occultation disappearance of the third satellite at 6h. 53m. P.M., and its eclipse reappearance at 11h. 42m. 31s. P.M. On the **6th** an eclipse disappearance of the second satellite at 7h. 48m. 3s. P.M. On the **7th** an occultation disappearance of the first satellite at 11h. 42m. P.M. On the **8th** a transit ingress of the first satellite at 9h. 1m. P.M., of its shadow at 9h. 24m. P.M.; a transit egress of the satellite at 11h. 21m. P.M., and of its shadow at 11h. 44m., P.M. On the **9th** an occultation disappearance of the first satellite at 6h. 8m. P.M., and its eclipse reappearance at 8h. 49m. 59s. P.M. On the **10th** a transit egress of the shadow of the first satellite at 6h. 13m. P.M. On the **11th** a transit ingress of the second satellite at 11h. 28m. P.M. On the **12th** an occultation disappearance of the third satellite at 10h. 12m. P.M. On the **13th** an occultation disappearance of the second satellite at 6h. 32m. P.M., and its eclipse reappearance at 10h. 23m. 35s. P.M. On the **14th** a transit ingress of the fourth satellite at 11h. 3m. P.M. On the **15th** a transit ingress of the first satellite at 10h. 46m. P.M., and of its shadow at 11h. 19m. P.M. On the **16th** an occultation disappearance of the first satellite at 7h. 53m. P.M., and its eclipse reappearance at 10h. 44m. 42s. P.M. On the **17th** a transit egress of the first satellite at 7h. 32m. P.M., and of its shadow at 8h. 7m. P.M. On the **20th** an occultation disappearance of the second satellite at 8h. 49m. P.M. On the **20th** a transit egress of the shadow of the second satellite at 7h. 12m. P.M. On the **23rd** an eclipse reappearance of the fourth satellite at 6h. 22m. 27s. P.M., a transit egress of the third satellite at 7h. 2m. P.M., an occultation of the first satellite at 9h. 39m. P.M., and a transit egress of the shadow of the third satellite at 9h. 54m. P.M. On the **24th** a transit ingress of the first satellite at 6h. 58m. P.M., of its shadow at 7h. 42m. P.M.; a transit egress of the satellite at 9h. 18m. P.M., and of its shadow at 10h. 2m. P.M. On the **25th** an eclipse reappearance of the first satellite at 7h. 8m. 17s. P.M. On the **27th** an occultation disappearance of the second satellite at 11h. 7m. P.M. On the **29th** a transit ingress of the shadow of the second satellite at 6h. 54m. P.M., a transit egress of the satellite at 8h. 10m. P.M., and of its shadow at 9h. 49m. P.M.

Neptune is an evening star, rising about noon on the **1st**, with a northern declination of 21° 12′, and an apparent diameter of 2·6″. On the **29th** he rises at 10h. 14m. A.M., with a northern declination of 21° 13′. He describes a very short retrograde path in Taurus during the month, a little to the south of the 4¾ magnitude star ι Tauri. A map of the stars near his path will be found in the *English Mechanic* for August 16th, 1895.

There are no very well marked showers of shooting stars in February.

The Moon enters her last quarter at 0h. 38m. A.M. on the **6th**; is new at 4h. 13m. P.M. on the **13th**; enters her first quarter at 9h. 14m. P.M. on the **21st**; and is full at 7h. 51m. P.M. on the **28th**. There will be a partial eclipse of the Moon on the evening of the **28th**. The first contact with the penumbra occurs at 5h. 15m. P.M., with the shadow at 6h. 16m. P.M., at 85° from the north point of the Moon's limb towards the east (reckoning for direct image); the middle of the eclipse at 7h. 46m. P.M.; the last contact with the shadow at 9h. 15m. P.M., at 30° from the north point of the Moon's limb towards the west (reckoning for direct image); last contact with the penumbra at 10h. 16m. P.M. Taking the Moon's diameter at 1, the magnitude of the eclipse will be 0·87. The Moon rises at Greenwich at 5h. 27m. P.M.

Chess Column.

By C. D. LOCOCK, B.A.Oxon.

Communications for this column should be addressed to C. D. LOCOCK, Burwash, Sussex, and posted on or before the 12th of each month.

ANSWERS TO CORRESPONDENTS.

A Norseman.—All your postcards were received too late to reply to last month. Please send your address for registration next time you write. Your solutions were correct.

A. G. Fellows.—Many thanks for your letter, explaining that an alteration of your problem at the last moment gave rise to the superfluous solutions. We believe that this is the first unsound problem of yours published in this column.

THE EIGHT QUEENS PROBLEM.

(*Continued.*)

We now proceed to remark on the principal features of the table of possible positions given in the January number:—

1. Evidently the positions of most frequent occurrence are those beginning a3, *b*6, etc. Of course the same would apply to positions beginning a6, *b*3, or ending g3, h6, or g6, h3, for all these are practically the same, the difference being merely one of right or left, backwards or forwards.

2. Each of the positions labelled α, β, etc. . . . . λ occurs *four* times in the table of forty-six positions; it seems, therefore, remarkable that the symmetrical position ω should occur only *twice*. Also that, in both the cases in which it is found, the position is absolutely identical if the board be turned half-way round (*i.e.*, two quarter turns). This may be seen at once by referring to the two diagrams ω and ω_3 in the last number. We believe that the coincidence is confined to these two positions.

3. In three out of the four classes (A, B, C) the squares h7 and h8 are never filled. In other words, a Queen can never be placed on KR7 or KR8 when there is a Queen on QRsq or QR2 or QR3.

4. We now arrive at the interesting question whether

the fundamental positions α, β, γ, etc. . . . λ, and ω are in any way connected—*i.e.*, whether one position can be obtained from another by a uniform shifting of the pieces in some definite direction. To this question we find the remarkable answer that some of the positions are in this way intimately connected with one another, while the remainder seem to be entirely independent. The positions which, for want of a better word, we shall call "transferable" are those labelled α, β, γ, δ, ζ, ι, and λ. The remainder, ε, η, θ, κ, and ω, are not transferable by any process which we can discover. And yet the italicized positions, Nos. 9 and 10 in Class C, and still more Nos. 4 and 5 in Class D, show how nearly the non-transferable θ approaches to the transferable α. In the latter instance the six Queens to the left remain the same; θ being obtained from α simply by shifting the Queens on KKtsq and KR5 to KKt5 and KRsq. In no other case is such a trifling alteration possible, so to speak, at the last moment.

5. The connection between α, β, γ, δ, ζ, ι, and λ is as follows:—To obtain δ from α, move the pieces *forward one square*. (A Queen on c8 must, of course, be shifted to c1.) Now move the position δ forward one square and we obtain ι. Again take α, and move the pieces *one square to the right*; this results in the position γ.

λ is obtained from α by moving the pieces one square *forward diagonally to the right*.

The rule for diagonal shifting is as follows:—A piece shifted to an imaginary square in continuation of a rank or file must be placed at the *other* end of such rank or file, while a piece shifted beyond a *long diagonal* must be placed at the opposite corner of the board. For instance, a piece moved one square forward diagonally to the right from QB8 must be placed on Qsq; if from KR8, it must be placed on QRsq.

To obtain β from α, shift the pieces one square *backwards diagonally to the left*—*i.e.*, precisely in the opposite direction to that used for obtaining λ.

ζ is obtained most easily from δ by moving the pieces one square *backwards diagonally to the right*.

[ω_2 is obtained from ω by a curious method. Move the pieces on files a and b one square *forwards:* files g and h one square *backwards:* the two distant pieces one square to the *left:* and the two nearer pieces one square to the *right*.]

6. We will now endeavour to ascertain why the positions ε, η, θ, κ, and ω are not transferable by any shifting of the pieces in a uniform direction. For this purpose we give a list of these five positions.

	a	b	c	d	e	f	g	h
(ϵ)	3,	6,	2,	5,	8,	1,	7,	4.
(η)	2,	5,	7,	4,	1,	8,	6,	3.
(θ)	2,	7,	5,	8,	1,	4,	6,	3.
(κ)	2,	6,	8,	3,	1,	4,	7,	5.
(ω)	3,	5,	2,	8,	1,	7,	4,	6.

[We have placed the names of the files at the head of the columns in order to have the figures themselves close together for comparison.]

Now, examining these figures, we notice—

(i.) That the square e1 occurs in every case except (ϵ).

(ii.) In every case except that of (κ) the figure 8 is next to the figure 1: moreover, this will be found to be the case *whichever way the board is turned*. In the transferable positions the figures 8 and 1 are *never adjacent*.

(iii.) In ε, η, and θ the number of a is within one unit of the number of h. *This is never the case in any of the transferable positions.*

We conclude, therefore, that the conditions which do *not* favour the simple transference of one position to another are:—(i.) The use of e1 (King's square) when a1, a2, a3, or a4 are occupied. (ii.) The use of *opposite* ends of *adjacent* files. (iii.) The use of a number on one Rook's file within a unit of the number used on the other Rook's file.

7. Finally we arrive at the question—why are there ninety-two methods of solving the problem, neither more nor less? Our mathematical abilities proving insufficient for the deductive solution of this question, we tried the device of using smaller chess-boards of 16, 25, 36, and 49 squares respectively, hoping to find some recognizable series of numbers which should determine the law. In this we were disappointed, for whereas the numbers increase generally with the size of the board, there is a remarkable exception in the case of the board of 36 squares. Our results are recorded below:—

Board of 16 squares			*Actual methods*—2		*Essential methods*—1	
,,	25	,,	,,	10	,,	2
,,	36	,,	,,	4	,,	1
,,	49	,,	,,	40	,,	6
,,	64	,,	,,	92	,,	12

In the Six Queens problem on a 36-square board the comparatively small number of solutions seems to be atoned for by their symmetrical beauty. It is remarkable also (1) that the corners are never occupied, and (2) that the *colours* of the squares are never equally divided among the Queens—there are always four Queens on one colour and two on the other. On the full-sized board, four of the Queens must always be on White squares and four on Black.

In conclusion, we must apologize if, in our examination of this (to us) intricate problem, we have anywhere sacrificed intelligibility to condensation. We sincerely hope, also, that any reader who knows or can discover the law which governs the problem will kindly communicate his information.

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NOTICES.

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